THE AMERICAN GAS LIGHT JOURNAL

REDMAN & KENNY, N.Y.

PUBLISHING OFFICE No. 32 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, VENTILATION, WATER SUPPLY AND DISTRIBUTION, & GENERAL SCIENCE.

VOLUME LXV.—No. 2. Whole No. 1,101. | NEW YORK, MONDAY, JULY 13, 1896 | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. E. SANDERSON, Manager.
JOS. R. THOMAS, C.E., Editor. T. J. CUNNINGHAM, Asst. Editor.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

Published on each Monday of the year, at No. 32 Pine Street, New York.

Collections are invariably made directly from this office for subscriptions, advertisements, etc. We have agents to solicit the same, but they are not authorized to receipt for money.

The American News Company, Nos. 39 and 41 Chambers street, New York, are agents for this JOURNAL. Newsdealers will send orders to them.

Correspondence.—Wishing to make this JOURNAL a gazette of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, correspondence is solicited for publication from all who make the study of those subjects a pleasure or a profession.

Terms of Subscription, Including Postage —For the United States and Canada, $3 per annum. European countries, $4.50 (19 shillings—22½ francs). All payments to be made in advance. Single copies, 10 cents.

Remittances should be made either by post office order, express money order, registered letter, or bank draft on New York, payable to the order of A. M. Callender & Co.

Books.—We will forward by express, at publisher's lowest rates, any book—scientific or otherwise—to any address in the United States or Canada. We would suggest to our patrons that to avoid the risk and expense consequent on sending us the money (we do not send books C. O. D.), that orders for books be sent us through the Purchasing Department of the American Express Company.

The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

CONTENTS.

An Asterisk (*) denotes an illustrated article.

EDITORIALS—

Briefly Told 41

Education and Engineering—Another Happy Man—Notes.

CORRESPONDENCE—

Mr. Enright's Views on Pressure in Relation to Leakage, etc..... 42

Street Illumination, by Mr. Walton Clark..... 42

Steam Boilers: Their Equipment and Management, by Mr. Albert A. Cary 43

On the Estimation of Sulphureted Hydrogen and Carbonic Acid in Gas Liquor, by Mr. H. Leicester Greville..... 45

Formation of Cyanogen from Ammonia..... 46

Science and Engineering, by Mr. T. Curtis Clarke..... 47

Lead vs. Iron for Supply and Vent Pipes, from a Plumber's Point of View..... 49

*The Corrosion of Iron by Raw Tar..... 50

Qualifications for Municipal Engineering, by Mr. C. C. Brown..... 51

Comparative Efficiency of Pintsch and City Gas 52

ITEMS OF INTEREST FROM VARIOUS LOCALITIES..... 53

Mr. C. F. Adams Promoted—Mr. H. C. Slater Goes to Milwaukee—Cheaper Gas for Norfolk, Va.—Mr. Jenkins Explains His Figures—Receiver for the St. Cloud (Minn.) Company—The Massachusetts Pipe Line Gas Company—The Rome (N. Y.) Company Changes Hands—The Hazelton Boiler Grows in Favor—Hints from Fishkill, N. Y.—Another Verdict Sustaining the Welsbach Patents—Cheaper Gas for Chicopee, Mass.—Filling Vacancies, Newton, Mass.—Public Lighting, San Antonio, Tex.—Cheaper Gas for Rockford, Ills.—The Quality of Minneapolis Gas—Something about the Duluth (Minn.) Gas and Water Company—And Many Other Items.

Incandescent Gas Lights for Lighthouse Illumination 54

Clay Pipe Sewers..... 55

The Market for Gas Securities..... 55

BRIEFLY TOLD.

EDUCATION AND ENGINEERING.—The paper read by Mr. A. C. Humphreys before the last meeting of the Western Gas Association, on the subject of "Self-Education in Gas Engineering," provoked a brisk discussion when its lines came in for comment from the delegates; and, further than that, it seems to have led to many moments of thoughtfulness since the members returned to their homes, for even to the present time references are made to the paper within our hearing by visitors to the JOURNAL office. We might go further and say that such references are not by any means confined to the paper alone, for the truth is the comment applies as often to the sentiments or opinions put out in the discussion as to the set lines that brought it about. Of course, this shows that both had vitality, wherefore Mr. Humphreys has the satisfaction of knowing that his labor was not in vain; indeed, he may fairly claim that it was in good measure repaid. Without making any criticism of it here, other than to say that, in the main, all thoughtful students will generally agree in its statements and conclusion, which latter may be summed up as holding that, in the race for pride of place in the profession of gas engineering, he who is equipped by a course of training in a well-directed technical institution is likely to win over his competitor who had not the benefit of such tuition. Still, Mr. Humphreys, in this conclusion, is not to be taken as holding that all graduates are bound to triumph over non-graduates, simply because of the possession or the non-possession of the parchment that does not of necessity guarantee that its holder shall become great. Between the lines of his paper he recognizes the force of the personal factor, the potency of the knowledge that such factor in the self-trained man may force him to the front, well in advance of a competitor who, having enjoyed the initial great advantage of technical training, failed of going on through a default in, shall we say, stamina. In the main, however, the trained one in any field is the one most likely to win. In the spirited discussion that followed Mr. Humphreys' paper, Mr. Walton Clark took a very prominent part, and he evidently had the courage of his convictions, for what he had to say was put together forcibly and was uttered in the spirit of sincerity. At first glance one might be taken in to the point of believing that he did not award to a technical training everything that was its due; but such is not the case, for his argument in no respect tends to the thought that technical education is narrowing, any more than it does to the belief that "practical experience" is not broadening in its teachings. Apart from such speculations or deductions, however, what impressed us most in his argument was this, in which he explained in greater detail that which he sought to convey respecting the personal factor in the instance of the technical graduate on entering the field where his life's work was supposed to be developed and enlarged: I may have said (perhaps awkwardly) that a technical education sometimes makes a man a disagreeable person to associate with; but if I said that, it did not quite express my meaning. I meant to say that the boys who come from purely technical schools, or from schools in which the technique only is taught, do not come to us fitted to do the work tha' they could do if they had something else besides that technical education. In other words, to be able to do the work which a technical education is sup-

posed to teach a man to do, he must know something more than is taught in technical schools.

This presentation of the case cannot be gainsaid, for everybody knows, and the "everybody," of course, includes every college graduate who went forth to conquer, that the technically trained man who survives his first decade of contact with the practical world, readily and cheerfully admits at the end of that period that he "knows more now than he did then." We had no thought of referring in the JOURNAL to the Humphreys' paper and the discussion it brought out, preferring to leave both with our readers for their own turning over; but a study of the inaugural address[1] of that veteran (Mr. Thomas Curtis Clarke), engineer—practical man though he be—at the meeting of the American Society of Civil Engineers last month led us on to what we have said. And as a conclusion to our mention we submit that the Society's President comes pretty near to hitting the mark aimed at both by Messrs. Humphreys and Clark, when he said: "The war between theory and practice has nearly come to an end. We now recognize that either without the other is not of much value. The practical man is one who has had experience in his own special line, and within his narrow limits, he is not likely to make mistakes. The theoretical man without experience is a dangerous guide. Hence we wisely treat the young man, trained only to the schools, as an apprentice, and make him follow instructions until he gets experience. When he has got it he rises very fast, and soon becomes a master, and, in the race of life, passes the 'rule-of-thumb' man."

ANOTHER HAPPY MAN.—It is needless to say that men skilled in diplomacy are always successful; since the successful diplomatist must of necessity be a man of persuasion. Last March Mr. Joseph Gwynn was awarded by his brethren of the Ohio Association the diplomatic palm for his persuasive policy in dealing with the tax raisers of the Ohio Legislature, and now the fraternity at large will speed to congratulate him over the entirely successful outcome of his negotiations with Miss Nellie May Howell, of Fostoria, Ohio, for the twain were made one on the evening of June 30th. The Reverend J. A. Patterson spoke the words that bound them, and they will receive their friends, on the "Wednesdays after July 20th," in their pretty home, 477 South Fourth street, Steubenville, Ohio. Good luck to them.

NOTES.—At the annual meeting of the Milwaukee (Wis.) Gas Light Company the following officers were chosen: Directors, E. McMillin, S. M. Green, F. G. Bigelow, A. E. Smith, J. P. Murphy, H. C. Payne, B. M. Weil, W. Becker and E. G. Cowdery; President, E. McMillin; Vice-Presidents, B. M. Weil and S. M. Green; Secretary and Treasurer, S. J. Glass; General Manager, E. G. Cowdery.——The semi-annual dividend of 2 per cent. on the stock of the Leominster (Mass.) Gas Light Company is payable on the 15th inst.

Correspondence

[The JOURNAL is not responsible for the opinions expressed by correspondents.]

Mr. Enright's Views on Pressure in Relation to Leakage, etc.

OFFICE OF THE MERIDIAN GAS LIGHT COMPANY,
MERIDIAN, MISS., June 30th, 1896.

To the Editor AMERICAN GAS LIGHT JOURNAL: Seeing a cut of Mr. James Ferrier's device, adapted for delicate pipe testing, in your issue for June 15th, I am at a loss to know of what possible use same can be for all practical purposes. It is true that such an instrument will show leakage where same exists, but as the inspection and test of all pipework are generally performed in the daytime, I fail to see how a delicate test of the nature described could be termed sufficient and reliable, when made under day pressure, for we all know that our night pressure is 50, and, in some cases, 75 per cent. over that necessary to carry in the daytime. As a rule, the testing of any kind of piping made under holder pressure is very unreliable and unsatisfactory, from the fact that the very nature of any test demands a much superior weight or pressure than the matter in question is called upon to carry in actual, everyday use. I compel all gasfitting, as well as street main, to stand a pressure of 10 pounds of air. When this rule is strictly followed, in regard to the laying of mains, you will not find much money or time lost over leakage account. I use a self-acting Connelly governor, and my pressure varies from 12 tenths in the daytime to 20 tenths in the nighttime.

Had I the time I should like to state my experience and the many advantages derived from a careful and enforced systematic system of house piping. I find that same will not only give satisfaction, but will materially increase your consumption and reduce complaints to a minimum. Yours truly, J. H. ENRIGHT, Supt.

1. See JOURNAL, p. 47.

Street Illumination.

[A paper read by MR. WALTON CLARK, of Philadelphia, before the Convention of Municipal Street Lighting Officials, New Haven, Conn., June 18, 1896.]

This occasion is, I believe, unique in the experience of American municipalities and American lighting companies. For the first time in our experience representatives of American cities meet for conference upon the all-important question of street illumination, and are addressed upon this subject by officials of gas, electric and other lighting companies.

I have to thank you for the honor of a place upon your programme. I hope I appreciate the privilege of addressing you, the responsible representatives of your several cities, upon the general subject of immediate interest, and at this, your first gathering. The importance of your particular branch of municipal administration can hardly be exaggerated, and the interest in it has at no time been greater than in these closing years of the 19th century. I look for mutual benefit as the result of this gathering, where city officials and the representatives of illuminating companies meet and compare experiences, gained amid different surroundings and under conditions of climate, foliage, pavement, architecture, etc., as various as the cities represented.

To the industry in which I am engaged the results of the discussions to take place to day and to-morrow must be of value. We shall hear you freely discussing questions relative to matters wherein we have dealings with you, exchanging experiences among yourselves without the consciousness which must be ever present in your dealings with us that you must be on your guard against our blandishments, minimizing the importance of the service we render, and, in the end, make the best possible trade in the interest of the constituencies which you represent. The value of this meeting to you will come largely from the opportunity of hearing advocates of different systems of street lighting discuss, freely and vigorously, the relative merits and demerits of their systems, which may give you an insight into lighting matters that you would not get from listening to the one sided statements of the lighting companies who are endeavoring in your cities to obtain contracts for public lamps. In the end, and from the discussions, truth will be served, and I apprehend as we talk together we will find that there is a mutuality of interest that does not appear when we of the lighting fraternity are endeavoring to persuade you to give us what we deem a fair price for our commodity, while you are endeavoring to obtain that commodity from us at the lowest possible cost to the people who have intrusted you with the conduct of their municipal affairs. I apprehend we will find that there is no ground for the suspicion with which, possibly, you and we have heretofore regarded each other; and we may reasonably hope that, from the discussions of the hour, will grow up a better understanding between us, and that, after this meeting, if not at present, we will trust each other, to our mutual benefit, as well as to the economy of your city funds, and to the efficiency and satisfactory lighting of public places.

It would be difficult to exaggerate the importance of efficient street illumination to the preservation of the public safety, the public health, and the public morals. A comparison of the present conditions of the streets of large cities with the streets of London before the introduction of general street illumination demonstrates my claim, that the thorough illumination of streets is more potent in the preservation of safety, health and morals of the public than any other one influence.

Macaulay, in his "History of England," refers as follows to the dangers of the London streets after dark, and before the initiation of a street lighting system:

"When the evening closed in, the difficulty and danger of walking about London became serious indeed. The garret windows were opened and pails were emptied, with little regard to those who were passing below. Falls, bruises, and broken bones were of constant occurrence. For, till the last year of the reign of Charles the Second, most of the streets were left in profound darkness. Thieves and robbers plied their trade with impunity; yet they were hardly so terrible to peaceable citizens as another class of ruffians. It was a favorite amusement of dissolute young gentlemen to swagger at night about the town, breaking windows, upsetting sedans, beating quiet men, and offering rude caresses to pretty women."

What this great historian thought of the influence of street illumination upon the happiness and safety of the people is shown by a further extract from his "History of England." He says:

"It ought to be noticed that in the last year of the reign of Charles the Second began a great change in the police of London—a change which has perhaps added as much to the happiness of the body of the

people as revolutions of much greater fame. An ingenious projector, Edward Heming, obtained letters patent, conveying to him for a term of years the exclusive right of lighting up London. He undertook, for a moderate consideration, to place a light before every tenth door, on moonless nights, from Michaelmas to Lady Day, and from 6 to 12 of the clock. Those who now see the capital all the year round, from dusk to dawn, blazing with a splendor compared with which the illuminations for La Hogue and Blenheim would have looked pale, may perhaps smile to think of Heming's lanterns, which glimmered feebly before one house in ten during a small part of one night in three. But such was not the feeling of his contemporaries. His scheme was enthusiastically applauded and furiously attacked. The friends of improvement extolled him as the greatest of all the benefactors of his city. What, they said, were the boasted inventions of Archimedes, when compared with the achievement of the man who had turned the nocturnal shades into noonday? In spite of these eloquent eulogies, the cause of darkness was not left undefended. There were fools in that age who opposed the introduction of what was called the new light as strenuously as fools in our age have opposed the introduction of vaccination and railroads; as strenuously as the fools of an age anterior to the dawn of history doubtless opposed the introduction of the plough and of alphabetical writing. Many years after the date of Heming's patent there were extensive districts in which no lamp was seen."

We may all smile at Macaulay's reference to London "Blazing from dusk to dawn with the splendor compared with which the illuminations for La Hogue and Blenheim would have looked pale," as Macaulay smiled to think of Heming's lanterns. The illumination of London to-day is probably as much superior to that of Macaulay's day as the illumination of Macaulay's day was to the modest effect of the inventor Heming. But such was the modest beginning of what is to-day one of the most necessary branches of municipal administration; and, modest as it was, it deserves recognition and record.

References to street illumination are found in many histories of ancient times, and in the Bible. We learn from the Book of Judges that a torch or flambeau was carried by the soldiers of Gideon. An early Jewish marriage custom required the groom to conduct home the bride by night, preceded by men bearing lamps and torches. The party of men who went out from Jerusalem, to apprehend Jesus in the Garden of Gethsemane, were provided with lanterns and torches. It is to be observed that all the references to ancient street illumination refer to lanterns or flambeaux carried in the hand. The idea of illumination, by which a man could walk through the streets without carrying a light with him, does not seem to have occurred to the ancients.

The first reference to anything that deserves to be called a system of street lighting in history is recorded in Draper's "Intellectual Development of Europe." Speaking of the Arabs, the wonderful people who maintained a brilliant civilization in Spain when the rest of Europe was plunged in intellectual darkness, he says:

"Cordova, at its highest point of prosperity, boasted of more than 200,000 homes, and more than 1,000,000 of people. After sunset a man might walk through it in a straight line for 10 miles by the light of the public lamps. Seven hundred years after this time there was not as much as one public lamp in the city of London."

With the expulsion of the Arabs from Spain was ended all serious effort to light a street in a way that would be in our day called efficient, until the advent of gas lighting. The first public street lighting with gas, and the longest step ever made in the improvement of public thoroughfares, bears date of the 28th of January, 1807. On the night of that day Pall Mall, London, was lighted with gas lamps, of probably not more than 12 candle power, infrequently placed. From that humble beginning has grown the system of street lighting which is to-day one of the prides of our civilization; and, from January, 1807, dates the age of modern street illumination.

The object of street illumination is, in the language of Scripture, "To dispel the outer darkness," to the preservation of the public peace, the prevention of immorality, and the securing of the safety of the night traveller. It is not to turn night into day. Man has developed into a creature of day and night, depending upon the alternation of light and darkness for the opportunities of labor and rest. The rest for the eye is as important as the rest for any other member of the body. Given day as the natural time for labor, night is the period of rest and recreation. There being provided sufficient light for the purpose of the moment, more light is wasted and may be injurious. If, as claimed above, the purpose of street lighting is the preservation of the public safety, and the protection of the public health and morals, when we have our streets so lighted that the traveller or driver may pass through them without danger of falling into holes, stumbling over, or running into other pedestrians, or inanimate objects; that no person or vehicle may approach another unseen, and that the public streets may not afford the gloom desired of the brawler, or the immoral, there is sufficient light, and the street may be truly said to be satisfactorily illuminated.

In the solution of the practical question of how, most economically, to light the public streets, the first axiom refers to the necessity of avoiding contrasts of brilliantly lighted with shady spots. The ideal of street lighting would be accomplished if we could have the same intensity of illumination throughout, without shadows and without bright spots. The nearest practical approach to this ideal condition of uniformity will comprehend the use of a large number of lights of moderate candle power, rather than fewer lights of high candle power. The danger from shadows, caused by lights of high candle power, arises, not so much from the fact that the shadows are in themselves dark, as from the fact that the pedestrian walks into the shadow with his eyes accustomed to the more brilliant illumination of the open spaces, and, possibly, dazzled from the effect of the rays of the bright light, which have, for the moment, struck the retina of his eye.

The law that the intensity of illumination is inversely as the square of the distance from the source of light, is of the utmost importance in determining the best system of street lighting. By it we can accurately estimate the relative illumination of surfaces most remote from the source of light, with the various systems under consideration. It will prove to us that the value of a system is not necessarily determined by the total candle power of the lights supplied. Quite as important is the factor of distribution, and an application of the law of the inverse squares may prove that a better lighting effect can be had from a given total candle power, distributed in small units, than from a several times greater total in many times larger units,

There must be some standard by which the efficiency of a street lighting system may be judged, and I submit that, as the strength of a chain is gauged by the strength of its weakest link, so it appears reasonable similarly to value a lighting system by the comfort and security with which the night traveller may find his way through the least lighted part of the streets included in the system.

It will appear that this question has to do not only with the matter of absolute illumination, but also with the comparative illumination. For, as a man walks into a shaded spot, his perception of his road and surrounding objects is dependent, in part, upon the condition in which the illumination of that part of his path just traversed has left his eyesight. A strong contrast of light and shade makes the shade appear deeper.

One of the problems of urban and suburban street lighting has to do with the illumination of space beneath awnings and low branching trees. Trees are necessary to the beauty of cities, and important to the comfort and health of their citizens, and are not to be legislated away in any interest; but I submit to you representatives of municipal government the question whether there should, in the interest of efficient illumination, be a regulation of the trimming of low growing branches.

I have not specially discussed the question of the illumination of the amusement or show parts of large cities, the vicinity of railroad stations, hotels, and, possibly, other places where, for town advertising and other purposes, a more brilliant illumination is required than is generally necessary or desirable. This is because I believe that, for the illumination of all situations, the general principles recited above furnish a safe guide.

In nothing is a knowledge of first principles more essential.

Steam Boilers: Their Equipment and Management.

By ALBERT A. CARY, in *Cassier's Magazine.*

One of the first considerations to be taken up in designing a new boiler plant, as detailed recently by the author in a paper presented to the National Electric Light Association, is found in the question, "What style of boiler is best adapted to our work?" and after this is answered, the other question following closely at its heels is, "Are our available funds sufficient to equip this plant with the chosen form of boiler?" Unfortunately, we find by no means a small percentage of prospective steam users asking these questions in the reversed order, and it is due largely to this fact that we find so many tank makers in the boiler business, so many coal companies flourishing and growing rich at the steam users' expense, so many boiler insurance companies springing up in every section of the country, to say nothing of the profits of the owner of the boiler, which unnecessarily go to keeping

the boiler in repair and the coal pile replenished. All these troubles do not result from the doings of the "penny wise, pound foolish" man, but there is also a large percentage of the plants erected where ignorance has been the partner of the designer, and we find the outsider again reaping the profits which properly belong to the victim.

Where the load fluctuations on the engine are excessive, the boiler must be of such design that it will deliver a very large quantity of steam in a very short space of time, and this may be accomplished in several ways, viz.: First, by having a boiler with an abnormally large steam space; second, by having a boiler with a large water capacity and a moderate-sized steam capacity; third, by having large hot water storage cylinders to supplement the quantity of water held in the boiler; fourth, by running the boiler at a steam pressure several times higher than that used at the engine and delivering the steam through a very large reducing valve, which reduces and delivers the steam from the high pressure to the pressure required at the engine.

Each one of these methods has its own advantages and disadvantages, and the first one is probably the worst arrangement that could be made. In fact, it may be regarded as impracticable. An extremely large steam space is neither desirable nor necessary; it increases the size of the boiler unduly, as well as increasing the heat radiating surface. Our second method of caring for the very sudden demand for steam is by providing a large water capacity. Under these conditions a fall in pressure is depended upon to supply the demand continuously.

With such an equipment, when the throttle is suddenly opened, admitting steam to the engine, the steam from the steam space of the boiler first rushes into the cylinder, and we will say, for example, that the boiler pressure drops from 100 to 80 pounds. Let us next assume that we are drawing our steam from a plant of boilers holding 100,000 pounds of water. The temperature of the water under 80 pounds pressure, we know, is 323.9° F., while its temperature under 100 pounds pressure is 337.8° F. By turning to our steam tables we find the total heat in one pound of water under the above conditions as follows:

One pound of water under 100 pounds of steam pressure contains 308.7 heat units.

One pound of water under 80 pounds of steam pressure contains 294.0 heat units.

Thus, when the pressure drops from 100 to 80 pounds, the total heat required in each pound of water is less by 14.7 heat units. Multiplying this by 100,000, we have 1,470,000 heat units available for the generation of steam. Divide this by 886.7 (the number of heat units necessary to evaporate one pound of water at 323.9° F. into steam), and we find that we have 1,658 pounds of water evaporated during the time of the reduction of pressure from 100 pounds to 80 pounds. Now, if our engine uses 500-horse power, and 60 pounds of steam are required per hour per horse power (equal to one pound of steam per minute per horse power, or 500 pounds of steam per minute for 500-horse power), we divide 500 into 1,658; we see then that from this lowering of temperature or pressure we liberate sufficient heat to supply our engine with steam for about 3⅓ minutes, even though all other sources of heat are withdrawn, but this is not the case; the fire in the furnace will add its heat constantly at the same time, and thus we soon find an equilibrium established, and the boilers will finally be able to supply the engines steadily with the steam required.

Let us see how much of a boiler equipment we would need to cover the conditions we have just outlined. Let us suppose that we take horizontal tubular boilers, 66 inches diameter and 18 feet long, containing 46 four-inch tubes. One boiler of this kind (allowing one-third of the diameter vertically to measure the steam space) will hold about 14,000 pounds of water. Dividing this into the 100,000 pounds of water, we will find that it will require seven boilers, which, if rated by the regular builders' rating, would be sold at 668 horse power. This is about one-third in excess of the rated engine horse power, but, considering the excessive duty called for in such service, it can be considered as a well-balanced plant.

The third method of providing for a great and very sudden demand for a large quantity of steam is accomplished, as has been stated, by providing one or more large hot water storage tanks which are used in connection with one or more regular boilers. The principle of working in this case is the accumulating of large quantities of heat in the water held in these tanks under pressure, to be called upon when needed for steam-making purposes; a very similar principle is followed in storing electricity in storage batteries to be drawn upon at any instant when the current is needed. This is known as Halpin's system of thermal storage, and in the case under consideration its operation is almost identical to the second method just described—that is, it depends upon a fall in the steam pressure when the body of water gives up some of its heat which results in the formation of steam at a lower pressure. In this system, of course, a fewer number of boilers are used, but the quantity of water handled by these boilers is proportionally greater.

The arrangement of these thermal storage tanks in connection with the boilers is comparatively simple. The tanks are simply plain cylindrical boilers, but of course they must be capable of sustaining a pressure fully equal and generally much greater than the working boiler. The working boiler is run full of water, and is made to deliver a constant stream of hot water into the storage tanks, independent of the rate at which the steam is drawn from them, and for the best results this system should be run at at least 100 pounds pressure in excess of the pressure required at the engine.

We now come to the fourth method of supplying our sudden demand for steam, which was originated by the author. This is probably the most economical manner of solving this problem, first, as regards the original cost of the equipment, and secondly, as regards cost of operation. By this system the number of boilers required is reduced, the quantity of water needed is much less, and this consequently lessens the amount of fuel required, and the consumption of steam at the engine is also reduced. Of course we will need, for this system, boilers which can be safely operated under high pressure, and let us here (for the sake of comparison with the example we have given under our second system) suppose that we have in our new plant two water tube boilers, each having a rating of 250-horse power and running under 300 pounds pressure, supplying steam to our 500 horse power rolling mill reversing engine which is designed to work with 80 pounds pressure.

In the first place, we will be obliged to place reducing valves in our steam main, between the boiler and engine. This will probably require more than one valve, as there is too great a range in pressure between 300 pounds and 80 pounds to be successfully handled by a single valve. The object of these reducing valves is to receive the steam from the boiler at a pressure higher than that required at the engine, and, by means of throttling, reduce this higher pressure to the 80 pounds required. The fall in pressure at the boiler side of the valves may run all the way from 300 pounds down to almost 80 pounds, but the pressure on the reduced side of the valves will always remain a constant 80 pounds. Steam at any higher pressure than 80 pounds will only cause a waste of steam at the engine, on account of the high terminal pressure at the end of the stroke. This, of course, refers to our reversing engine, while with an automatic cut-off engine too high an initial pressure will cause, toward the end of the stroke, the wasteful negative pressure, which, on the indicator diagram, will be shown by the terminal loop.

Returning to our rolling mill engine, which is exhausted to the atmosphere, terminal pressure, of course, increases as the initial pressure is increased above 80 pounds. Thus it will be seen that reducing valves are a source of great economy in such practice. Those reducing valves must be very large—larger than required in ordinary practice.

As for the difference in expense in running boilers at a pressure of 300 pounds instead of 100 pounds, it is hardly worth consideration. Practically speaking, a pound of coal will evaporate the same number of pounds of water into steam at any pressure. To show the truth of this statement, let us take a pound of steam at 100 pounds pressure, and again the same weight at 300 pounds pressure. The total heat in the first is 1,185 heat units, while in the latter the total heat is but 1,209.3 heat units—a difference of only 24.3; and when we consider that our coal delivers between 13,000 and 15,000 heat units when burned, from 60 to 75 per cent. of which are utilized by the boiler in making steam, no difficulty can be had in comprehending the statement that practically the same amount of water can be evaporated per pound of coal, irrespective of the pressure.

Now, in order to investigate the working possibilities of this arrangement, let us consider our plant somewhat in detail. Taking a well-known horizontal water tube boiler, rated at 250-horse power, we find that under ordinary working conditions it contains about 20,000 pounds of water. Two of these, making a battery of 500-horse power, will therefore contain 40,000 pounds of water. As has already been stated, our 500-horse power rolling mill engine is designed to be operated with 80 pounds pressure. The steam space and steam liberating surface in these boilers are designed to be of sufficient size and capacity to secure dry steam when the boilers are supplying the maximum demand. It must be remembered that all sudden lowering in the pressure of boilers is followed by an increased ebullition of the water, which has a tendency to project particles of water into the steam space, and if ample space is not provided to allow most of these particles time to drop back

again into the water from which they have risen, before the out-rushing steam carries them away into the steam pipes, trouble is very apt to follow if this moisture is not entrapped or removed from the steam before it reaches the engine.

The exact steam liberating surface required in a boiler is pretty difficult to define, as experimenting in this direction has not determined this with any precision; but it is safe to say that when steam is taken from the surface of water at a speed greater than three feet per second, water is generally carried with it. A curious fact has been noted in this matter, and that is, after steam once begins to pick up water as it leaves its surface in a boiler, it will continue to do so for a considerable time, even though the speed of its exit is considerably less than the speed at which it first began to pick up the water. The advantages of reduced steam space have already been discussed under our first system. Next let us consider the amount of water required here, and compare it with the second system. Here we have 40,000 pounds in our boiler, while there we had 100,000 pounds.

One pound of water under 300 pounds steam pressure contains 391.9 heat units. One pound of water under 80 pounds steam pressure contains 294 heat units. The difference is 97.9 heat units. We thus find that a drop in pressure in our boiler from 300 to 80 pounds will render available, from each pound of water contained in the boiler, 97.9 heat units; therefore, with 40,000 pounds of water we will have available 3,916,000 heat units to generate quickly the steam required. Dividing this by 886.7 (the number of heat units necessary to evaporate 1 pound of water into steam from the temperature of water under 80 pounds steam pressure), we find that we will have generated 4,416 pounds of steam through this fall in pressure, and, as our engine requires 500 pounds of steam per minute, we find, by dividing, that we have a supply of steam which will supply our engines for 8.83 minutes, to say nothing of the steam generated directly by the fire during this interval.

Thus, we have almost three times as much reserve energy available as in the second system, while we have but two-fifths the amount of water. It is a well known fact that water tube boilers are very rapid steam makers, and in consequence of this, after dropping their pressure, as has just been stated, they will commence "picking up" immediately, and the nine minutes during which they are delivering steam from the available heat they have stored in the water under 300 pounds pressure are more than ample time for them to recover their maximum pressure again, and thus the desired result is accomplished.

To show where economy in operation occurs in this system, there are many points which may be considered. In the first place, there is a smaller number of boilers required, which need a smaller boiler house, thus economizing room. Fewer boilers require fewer attendants. There is in this system needed but 40 per cent. of the water that is necessary in the second one, and that means that it will require but 40 per cent. of the fuel, when starting the boiler, to raise the water from the temperature of the feed to the temperature of the steam, and it must be remembered that the amount of iron work and masonry to be heated and maintained at a working temperature is far less in this system than in any other.

If we have a single cylinder engine the lower pressure should be from 80 to 90 pounds, while with a compound engine, expanding its steam through two cylinders, 120 pounds has generally been found good practice. Passing steam through the reducing valve secures a most desirable result, aside from the mere reduction in pressure; that is, it either dries or superheats the steam delivered to the engine. A moment's reflection will assure us of this fact. We know that the total heat contained in one pound of saturated steam under 300 pounds pressure is 1,209.3 heat units, and as there is practically no external work done by the steam when passing through the reducing valve, this pound of steam, although reduced to a lower pressure, must contain the same number of heat units. Dry saturated steam at 90 pounds pressure we find contains only 1,182.9 heat units; thus we have (1,209.3—1,182.9) 26.4 heat units in excess of what is needed for dry steam. As dry steam requires but 0.48 of a heat unit to raise 1 pound 1 degree, we find that our reducing valve will raise the temperature of the steam at 90 pounds pressure, 55° F. above its normal temperature, providing the steam entering the reducing valve is dry. Should it, however, contain any moisture, this superheating effort will go toward evaporating the entrained moisture into steam.

I have already described the operation of the high pressure boilers working with their reducing valves, and now you will doubtless say, What saving can there be in fuel with this arrangement? In case our station has been working to its maximum limit, and the load is suddenly diminished, the heavy fires carried, in order to supply steam enough for our crowded engines, will require some little time to burn down to the point needed to supply steam under our reduced conditions. Again, after operating the boilers to supply a light demand for steam, and a heavy demand comes suddenly, how can our light fires be brought up quickly to the intensity needed to meet the new requirements? These apparent difficulties can easily be overcome by using a mechanical induced draft with a regulating device, which will vary the intensity of the draft to suit the requirements.

As everyone knows, combustion in boiler practice is controlled by the amount of air passing through the grates. As the supply of air is diminished, the fire grows dull, and finally, when it is shut off entirely, the fire smoulders and is soon extinguished. The regulated mechanical induced draft is arranged so as to control the air supply of the furnace, and it works between wide limits of variation in a very short interval. This device is simply constructed by placing a fan in the flue between the boilers and the chimney. This fan is driven by means of belting by a small steam engine working direct upon the driving shaft, or by an electric motor. The speed of each of these driving devices is regulated by means of an attachment which is moved as the steam pressure varies in the boiler, very similar to the well known action of the automatic damper regulator. This mechanically induced draft is not a patented device, and so is open to all for use.

There are many electric light plants in which this system can be used to great advantage without the addition of the economizer, which will materially reduce the cost of installation. In some of these plants we find the extreme maximum load lasting but two or three hours each day, and it will be merely during these times that the excessive temperature of flue gases exists.

After all, the matter of introducing any appliances to the steam plant resolves itself down to a simple commercial problem. Taking the matter of first cost and cost of installation, to which must be added the cost of maintenance, we can easily figure the interest on the investment. Next, after carefully considering the appliance, and securing, by personal investigation, the true results of other experience, you can determine with close approximation the real saving that the appliance will make to the plant. Next, balance up and you will be able to determine whether it is advisable to invest or not.

On the Estimation of Sulphureted Hydrogen and Carbonic Acid in Gas Liquor.

[Communicated by Mr. H. Leicester Greville, F.I.C., F.C.S., to the *Journal of Gas Lighting*.]

Many years ago, when contributing articles to "King's Treatise on Coal Gas," I published a simple and expeditious method of determining the proportion of sulphureted hydrogen in gas liquor, depending on the use of an ammoniacal solution of copper sulphate of definite strength. I have always employed this method with satisfactory results; but experience has suggested one or two modifications of more or less importance, which may possibly justify my republishing the details of the process.

There is no doubt that the elimination of ammonia from coal gas has a most important bearing in the removal of impurities. This fact has always been recognized; but it is accentuated in more modern years, by several factors. One is the increasing tendency to separate the whole of the ammonia from the gas, as a sequence of the rapid development of sulphate manufacture in gas works. Another factor is the greater efficiency of modern scrubbers, and more especially of modern washers, over similar appliances of an older type—ensuring a more intimate contact of the liquor with the gas, and therefore enabling the ammonia to extract the maximum percentage of impurities. How much is saved to an average gas company in the domain of such solid expenses of purification as expenditure on lime and oxide, by the employment of efficient washing and scrubbing appliances, is in many cases not sufficiently appreciated. If it were otherwise, we should find more attention given to these details, and possibly more capital expenditure on efficient machinery. If gas liquor, as is generally admitted, is of such great use for purposes of purification, simple means of ascertaining the actual amount of duty which it is performing must have a distinct and intrinsic value.

Dealing with the general estimation of sulphureted hydrogen and carbonic acid, I have always found it most convenient to formulate results in grains in preference to grams, more especially as the former are more readily calculable; in the case of the liquid taken for analysis, into gallons; and the gases estimated, into cubic inches or cubic feet. This method of expression is more intelligible to the average gas manager for practical purposes. It may possibly seem (using a somewhat vulgar vernacular) a mongrel plan, to employ a combination of the

gram and the grain system; but with regard to the estimation of impurities in gas liquor, I have pursued this course for some considerable time.

The cubic centimeter burettes furnished with glass stopcocks so much used for general laboratory purposes, are so neatly graduated, and have generally such artistic merit, that they seem to exercise (to me, at least, as a devotee of science) a special attraction. I have, as a consequence, for many years abandoned the use of the old-fashioned Bink's burette, with its subdivision of ounces for the estimation of the strength of gas liquor, and substituted the cubic centimeter burette. The transition is simple. Taking one volume of liquor, neutralized by an equal volume of 10 per cent. of sulphuric acid, divided into 16 parts, each part is equal to 1 oz. (so called) strength. I have had specially made small graduated flasks, holding 64 c.c., as a measure of the liquor to be tested. Working with this measure, and a 50 c.c. burette, charged with standard 10 per cent. acid, 4 c.c. of acid equals 1 oz. strength; and each cubic centimeter therefore equals ¼ oz. As each cubic centimeter is divided into tenths, and with methyl orange as an indicator, *versus* the old system of employing litmus paper, a degree of accuracy can be obtained far in excess of that attainable under the older system.

Turning from this digression to the main object of the present article, and taking the question of the determination of sulphureted hydrogen first, I prefer to prepare my standard copper solution from metallic copper, in preference to employing cupric sulphate as previously recommended. A convenient strength for ordinary work may be prepared as follows: Take 46.7 grains of clean metallic copper, in the form of thin foil or wire, and dissolve in a slight excess of nitric acid; being careful to prevent loss from spurting. When the metal is entirely dissolved, dilute with a small quantity of water, and add such an excess of liquid ammonia that the precipitate at first formed is perfectly dissolved with the formation of a clear blue solution. Then dilute with distilled water, until the volume is half a liter (500 cubic centimeter). This will give a solution of which each cubic centimeter equals 0.05 grain of sulphureted hpdrogen.

The *modus operandi* is then as follows: A 25 cubic centimeter burette is filled with the standard copper solution. Then 100 grains measure of the liquor to be tested is carefully measured, into a white porcelain basin, diluting with a little distilled water, and adding a small proportion of strong ammonia. Now run in the copper solution at first drop by drop, stirring vigorously, and noting the first appearance of a slight brown tint. Record how much copper solution has been used up to this point; and then run in more boldly, still stirring constantly. The solution will remain brown and turbid until the critical point is reached, when black copper sulphide will separate in heavy particles and rapidly settle down, leaving a colorless supernatent liquid. If too much copper solution has been added, the supernatent liquid will have a slight blue tint, and a second test should be made; but with a little experience in manipulation, this will be found unnecessary in ordinary cases.

I have made experiments as to possible errors arising from such normal constituents of gas liquors as sulphocyanides, hyposulphates, and cyanides. The two former have no effect, but the presence of cyanides certainly does influence the test. This source of error is, however, practically remedied by deducting from the total volume of the copper solution used the amount necessary to produce the first slight brown coloration, and calculating the proportion of H_2S on the difference. The percentage of H_2S in the sample is, of course, obtained (with 100 grains of liquor) by multiplying the number of cubic centimeters of solution used by 0.05. As an example, 100 grains measure of a sample of scrubber liquor, required a total of 6.6 of copper solution; but 0.8 was needed before the first indication of a brown coloration. The amount of copper solution, therefore, to be credited to H_2S, was 5.8, and $5.8 \times .05 = 0.29$ of H_2S per cent. This sample gave, by the ordinary precipitation process by arsenic solution, and weighing as As_2S_3, 0.28 per cent of H_2S. Adopting the same lines of procedure with other samples, the following results were obtained:

	H_2S by Volumetric Process.	H_2S by Precipitation as As_2S_3.
Condenser liquor	1.180	1.200
Scrubber	0.470	0.450
" check test	0.475	0.450
"	0.680	0.690
Condenser	0.410	0.390
Unnamed	0.107	0.106
Well liquor	0.607	0.600
Weak scrubber liquor	0.081	0.079

The test can be made in a few minutes.

With regard to the estimation of carbonic acid, the method of testing is almost as simple as that for sulphureted hydrogen. The only accurate test solution necessary is the ordinary 10 per cent. acid in use for the estimation of the strength of gas liquors. Beyond this, all that is required is a solution of ordinary calcium chloride, of an approximate strength of about 9 per cent. This may be easily prepared by dissolving half a pound of ordinary dry calcium chloride in some distilled water in a flask, and, as the solution is generally faintly alkaline, adding carefully some very dilute hydrochloric acid, until the liquid gives a neutral reaction. Dilute then to the volume of half a gallon, and filter into an ordinary Winchester quart.

The process depends on the fact that, whereas the ordinary 10 per cent. acid is an indicator of all compounds of ammonia in gas liquor capable of being decomposed by its action, the addition to the liquor of an excess of calcium chloride decomposes the ammonium carbonate present, precipitating calcium carbonate, and fixing the ammonia previously in combination with CO_2 as neutral ammonium chloride. The precipitated calcium carbonate being removed by filtration, the alkalinity of the filtrate is determined with 10 per cent. acid; and the loss of alkalinity is a measure of the proportion of CO_2 present. The reaction which occurs may be expressed thus:

$$(NH_4)_2CO_3 + CaCl_2 = CaCO_3 + 2NH_4Cl.$$

The mode of procedure is as follows: Take, say, 1,000 grains measure of the liquor to be tested, pour into a white porcelain basin, and (using methyl orange as an indicator) find how many cubic centimeters of 10 per cent. acid are required for neutralization. Having noted this, measure 2,000 grains of the liquor into a stoppered decigallon measure, and add 2,000 grains measure of the calcium chloride solution. Shake vigorously at intervals, and, after a brief period, the calcium carbonate will settle rapidly down as a dense precipitate. Pour the comparatively clear liquid on to a dry filter paper, filtering into a graduated measure, and when 2,000 grains measure have been obtained, pour this amount into a white porcelain basin, and determine the alkalinity with 10 per cent. acid as before.

The calculation is then simple. Sulphuric and carbonic acids are both what are termed "dibasic," replacing equivalent proportions of the same alkali in combination. The molecular weight of H_2SO_4 being 98, and that of CO_2 being 44, these figures represent the equivalency of the two acids with regard to the same base. With standard H_2SO_4 of 10 per cent. strength, 1 c.c. of 15.433 grains would contain 1.5433 grains of H_2SO_4—equal to 0.693 grain of CO_2. As an example, say that 1,000 grains of the raw liquor required 40 c.c. of 10 per cent. acid for neutralization, and an equal quantity (1,000 grains) of the filtered liquor, after treatment with $CaCl_2$, required for neutralization 20 c.c. of test acid. Then $40 - 20 = 20$ c.c. difference; and $0.693 \times 20 = 13.86$ of CO_2, equal to 1.386 per cent.

The following experiments demonstrate the accuracy of the process. The figures, showing determination by weight in comparison to the volumetric method, were made by washing and weighing the precipitated calcium carbonate, and then calculating the CO_2.

	CO_2 Per Cent. Volumetric Process.	CO_2 Per Cent. Gravimetric Process.
Condenser liquor	2.020	1.950
Scrubber "	1.800	1.840
" "	0.664	0.677
" "	0.680	0.690
Unnamed "	0.977	0.951
Surface condenser	0.762	0.763
Well liquor	1.630	1.640
Scrubber	0.069	0.074

The determinations of H_2S and CO_2 can be made easily in 15 minutes, the proportion of H_2S being estimated while the mixture of $CaCl_2$ and liquor are standing before filtration.

With regard to ratio of CO_2 and H_2S per cent. by weight and volume, it may be stated that at 30 inches B, and 60° F.—

1 per cent. H_2S = 1.11 cubic feet per gallon.
1 per cent. CO_2 = 0.8526 " "

By multiplying these factors by the weight percentages, the corresponding volumes in cubic feet per gallon may be obtained.

Formation of Cyanogen from Ammonia.

Engineering remarks that the occurrence of cyanide of potassium in blast furnaces was first, in 1837, observed by Thomas Clark, on the Clyde. The crusts and efflorescences forming about the tuyeres, especially after scouring, consisted of nearly equal parts of cyanide and

of potash. The observation was soon confirmed from other parts, but no adequate explanation of the occurrence has been given. The investigation which Dr. E. Bergmann has started, in conjunction with Dr. Bueb, on the instigation of Professor Bunte, does not settle the question whether or not the cyanogen in such cases is really derived from the free nitrogen of the atmosphere; but the experiments have a high practical interest. Dr. Bueb has not yet published his researches; Dr. Bergmann gives a detailed account of his share of the work in *Schilling's Journal für Gasbeleuchtung.* The study concerns the action of ammonia, diluted or not with illuminating gas or Dowson gas, on glowing charcoal. From a reservoir, provided with a gas meter, the gas passed through the bottle in which the ammonia was generated. The dried gases then entered a porcelain tube, filled with charcoal, which was heated up to 1,180° C. in a Fletcher gas stove; an aspirator was joined to the other end. The temperature was ascertained by means of Princeps' alloys, At 800° only 4 per cent. of the nitrogen supplied as ammonia was converted into cyanogen; at 1,000° 24 per cent. When illuminating gas was admixed, 60 per cent. could be gained at the highest temperature applied, 1,180°. Of the remaining 40 per cent. of the ammonia, 20 per cent. was recovered as ammonia, and 20 per cent. decomposed into nitrogen and hydrogen. The coal gas acts either simply as a diluent—and the experiments prove that a concentrated current of ammonia is not profitable—or it may be decomposed according to the formula $C_2 + 2NH_3 = 2CNH + 2H_2$. If the latter be the case, gas containing higher hydrocarbons should prove more effective; the addition of pentane was found useless, however, if not deleterious. There is a third possibility, $CO + NH_3 = CNH + H_2O$. This reaction would be important for Dowson gas. When working simply according to this formula, that is, without using charcoal, a little cyanogen was, indeed, formed, but the quantity was very slight. The experiments were made with about 6 grams of ammonia, 40 or 50 liters of the other gases, and lasted from one to three hours. The following is a summary of the results: Hydrocyanic acid, and not cyanide of ammonia, is formed when ammonia is passed over glowing charcoal; by-products are nitrogen and hydrogen, never methane. The addition of coal gas increases the yield of cyanogen, and keeps down the splitting up of ammonia into its constituents. Hydrocarbons of higher molecular weight seem to prevent the decomposition of the ammonia, becoming themselves decomposed, and their admixture is hence not advisable. Carbonic oxide behaves like coal gas, but it favors the splitting up of ammonia; the same applies to Dowson gas. These gases act as diluents; the diluted ammonia is not so easily split up as the concentrated ammonia. The current should not be too rapid. The temperature depends upon the nature of the gases added; on the whole, a temperature of 1,100° gives the best results. A certain percentage of ammonia always escapes unattacked. This percentage increases in the presence of hydrocarbons of higher molecular weight. Dr. Bergmann does not discuss the practical bearing of these researches.

Science and Engineering.

[Inaugural Address, by PRESIDENT THOS. CURTIS CLARKE, before the Annual Convention of the American Society of Civil Engineers, held in San Francisco, June 30, 1896.]

The subject of this address is "Science and Engineering," showing the necessary relations between them, which are becoming closer and closer every day, as engineering extends over wider and wider fields of action. Science is the discovery and classification of the laws of nature. Engineering, in its broadest sense, is the practical application of such discovered laws.

In ancient times knowledge was the treasured secret of a caste. In our day all can acquire it, and everybody stands on an equal footing. The education of the engineer is now becoming as broad as that of any of the other professions. Engineering has become a profession, but it is the latest of the professions. A brief description of the evolution of engineering will show why it is so.

The word "evolution" simply means growth, and there are but few now left who cling to the idea that God created his universe as we see it now. We believe that the world and all that is in it grew from the simplest forms, just as the tree grows from its seed, and the most highly organized animal from a germ cell. We see that in all cases this growth is from the simple to the complex, from a state where the parts are few and like each other, to a state where the parts are many and unlike each other, yet all working for a common end. Not only the universe, this planet, and all its animate and inanimate things, but also all social institutions and professions, and civilization itself, develop under this same law of evolution of growth from the simple to the complex.

Herbert Spencer, the great master of this subject, has shown that our present professions—law, medicine, architecture and engineering—have all developed from the clerical profession. A little reflection will show that this must be so. A profession requires special education and instruction on the part of its professors. In early times there was but one educated class—the clergy—and they were the only ones who knew enough to be lawyers, doctors, architects and engineers.

It is easy to see the connection of law and religion, as law was originally based on equity, and equity and morality form part of religious duty. Disease, in ancient times, was thought to be either an affliction sent by God or possession by the devil; hence the clergy were the proper medical men.

An art requiring so much technical skill as architecture was originally practiced by the clergy, as temples, churches and monumental structures naturally fell under their supervision. The great cathedrals of the Middle Ages were built by the higher clergy of those days, among whom William of Wykeham and Abbot Suger are deservedly famous. A curious survival of this is found among architects even now, who call everybody but themselves "laymen."

The earliest engineers of whom we have any record were the priests of Egypt, whose wonderful works in masonry are surpassed by no masonry work of our days; and the only way in which we can show our superiority is by our greater skill in the use of metals. Civil engineering did not become separated from the clerical profession until in much later times. We know this from the Latin word "pontifex," which means a bridge builder and also a priest, and from which the words "pontiff" and "pontifical" are derived. The Pope of Rome is still styled Pontifex Maximus, Supreme Pontiff, or chief bridge builder, whichever you please. The building of a bridge was considered such a remarkable feat that the name pontifex became the highest clerical title.

Men of inventive talent, not clergymen, displayed much skill in inventing and operating engines of war, hence the name engineer. Civil engineer was a later title, and thus indicates a later development. Civil engineering is the youngest of the professions, and the reason of its late evolution is this: If engineering be the application of Nature's laws, there could be no engineering profession until these laws were discovered. These discoveries did not come until late in the world's history. It was not until the human mind had become impressed with the constancy of the order of Nature, and that chance had no place in it, that the reign of law began, and men then strove to discover what were those necessary sequences of cause and effect that we call the laws of Nature.

The progress of science was much retarded by the conservative spirit. The works of Copernicus were suppressed. Galileo was imprisoned and Bruno was burned. Even Newton's splendid discovery of the laws of gravitation was not accepted by those pious persons who feared lest it might detract from the majesty of the Almighty to assume that He worked by law and not by caprice. Fortunately the world had grown wiser in Franklin's day, and readily believed that the tremendous flash of lightning could be imitated by rubbing a glass bottle with a silk handkerchief, or be drawn from the clouds by a boy's kite. Men's minds became open to receive knowledge. A common proverb says: "One thing leads to another." Hence it is that science in this century, freed from the stigma of impiety, and using instruments of the most marvelous precision, has been able to make so many new discoveries.

Some of those which have been made, even in my day, are as follows: The evolution of life has been shown by Darwin in his doctrines of variation and the survival of the fittest. The modern geology, which we owe to Lyell, teaches us that this globe came to its present condition by the operation of natural laws still in force, and not by a series of catastrophes. Its vast antiquity, even since the appearance of man, has also been demonstrated. The researches of Helmholtz, Joule and Faraday have shown the identity of light, heat, electrical and chemical action as transformations of energy, which has led to what is probably the most comprehensive scientific discovery of this century, the conservation or indestructibility of energy, binding into one law all dynamic action. This shows that power cannot be created, but only transformed, and proves the utter absurdity of Keely motors and of perpetual motion. Kirchoff and Bunsen have given us the spectroscope, which with equal certainty detects the infinitesimal part of a grain of some substance in the flame of a lamp, and also shows the presence of our familiar gases in the light of a star so far away that the ray which now reaches us started on its way before the beginning of

Egyptian civilization. The spectrum analysis has created the new astronomy, proving the uniformity of matter, and extending the reign of law all over the visible universe, of which we are but a mere speck.

Such are some of the later discoveries of pure science. Equally wonderful are the discoveries in those branches of science which can be applied to the use of man, and in whose application the engineer takes no mean part. We have now the new chemistry, which is synthetic as well as analytic. In other words, it not only investigates the composition of bodies, but has learned how to create them by its own processes, such as the invention of aniline dyes, oleomargarine, and the economic production of aluminum. It has revolutionized nearly every art and manufacture. The engineer Bessemer, in the art of metallurgy, has given us the modern steel, which has done so much to lessen the cost of transportation as the invention of the locomotive itself.

Another very important late discovery in medico-biological science is that of the presence of those infinitesimal beings called microbes, which, although so small, exercise such a great influence upon human life and health. Here the labors of the engineer have come into play and have shown us how to purify water by sand filtration. The experiments of the engineers of the Massachusetts State Board of Health have shown us that sewage, being destitute of oxygen, must be applied to filter beds slowly and intermittently from above, so that air can follow it down and aerate the purifying microbes, and keep them alive to do their work. By this means the worst water can be made chemically pure.

By far the most striking application of science in this century has been in electricity. Morse and Henry have given us the telegraph; Bell, the telephone; Edison, the incandescent lamp; Tesla, the alternating current; and McFarlan Moore hopes soon to give us artificial daylight from glass tubes, in which are no loops nor carbons, but only repeated interruptions of an electric current in a high vacuum. It has also given us the separation of metals from their solutions, and the economic transmission of energy, which has recreated our street railways, machine shops and manufactories, and may soon supersede steam locomotives where frequent stops are necessary. Its new discoveries come so fast that one can hardly write them down. Even while preparing this address a great discovery is announced. It has been the dream of investigators to find some means of producing electrical energy from coal without combustion. We now hear of a very simple process by which over 80 per cent. of the potential energy of carbon can be converted into electrical energy by causing the oxygen of the air to combine with carbonaceous material, through an intervening electrolyte, preferably melted caustic soda, according to Professor Cross, of the Massachusetts Institute of Technology.* Assuming that this is true, we may say positively that this discovery will not be of value until the engineer has put it into such practical shape that it will be commercially successful. It may take the place of chemical batteries, but that it can supersede the steam boiler, where great power has to be produced, seems doubtful. The steam boiler has never had a fair chance until lately. Fuel was crammed under it by ignorant stokers, and the combustion was imperfect for want of oxygen. The scientific engineer has now applied a system of mechanical stoking, which develops much more energy from a pound of coal.

To return from this digression, we may say that electrical discovery has created a new branch of our profession. The discovery of the X rays is but in its infancy. It can show our bones, but has not been able to penetrate a steel eyebar and show the bridge engineer any hidden defects. It seems probable that its application to incandescent lighting is near at hand. The engineers are working at this problem.

Little time is left to speak of military engineers, who are well represented in our Society. By them the laws of nature are applied for the defense of mankind, without which the arts of peace would avail but little. Experience in the last great wars has shown that that nation which has made the greatest advances in engineering is the most formidable in war. It has been well pointed out by the President of the British Institution of Civil Engineers that all improvements in modern instruments of both attack and defense are the work of engineers. High power guns and armor plates, repeating rifles and torpedoes, were invented by engineers.

Engineers are now developing and improving a very old invention—the submarine boat. Modern discoveries have furnished it with aids which appear to at last make it practicable. It can now carry its motive power for use in action in storage batteries. Improvements in handling compressed air make breathing possible. Electric wires can control the discharge of high explosives. If its direction can be controlled it will revolutionize naval warfare. The battleship will have to be designed anew so as to carry several of these submarine boats on her deck. They are torpedoes with men inside of them able to direct them intelligently and evade any nets or other protection that the battleship may have. For harbor defense a larger class can be used.

Before the close of this century we may see another new branch of engineering. Through the labors of engineers man has extended his dominion over both sea and land. Through the labors of engineers he may soon extend his dominion over the air, and aviation engineers may be as numerous as mining engineers now are.

Such are some of the later discoveries of science. Each new discovery leads to still another, and what we know now is as nothing to what we will know in coming years. All the great discoveries of science have been made by the application of what is called the scientific method of investigation. This is as necessary to the engineer as it is to the investigator of pure science. Unless he is equipped with it and understands its use he will always occupy a subordinate rank instead of taking his true place as a master of creative science, which I shall show that engineering really is. Scientific method consists of observation, deduction and experiment. It has been well said that a healthful skepticism is the parent of observation. Men are naturally lazy, and it is easier to take things for granted than to observe and find out for one's self. In deduction we must beware of hasty conclusions. We must be careful not to be deceived into thinking one thing is caused by another because it comes after it. Unscientific persons think that changes of weather are caused by the moon, and bimetallic philosophers imagine that the kind of coinage with which they buy or sell things affects their value.

On the other hand we must not be deceived into thinking that one thing has no connection with another because we do not see that connection. There was a common proverb in England that Tenterden Steeple was the cause of Goodwin Sands, a dangerous quicksand near the mouth of the Thames that has swallowed up many vessels. Common people believed this. The wise called it a vulgar superstition, or possibly a coincidence. Lately a scientific observer examined the archives of Tenterden Church, and found there documents showing that a fund, whose revenues had been applied toward maintaining a dyke shutting off a certain arm of the sea, had been diverted by the Abbot of Tenterden to build a steeple for his church. The dyke being neglected for want of money, the sea burst in and caused the Goodwin Sands. So the vulgar proverb was right after all. This illustration shows how necessary it is not to draw hasty conclusions, but to sift the facts after collecting them, rejecting those that have no bearing, and taking great care not to overlook or reject those that are of importance.

In forming a theory to account for the phenomenon, one must be very patient and get all the facts first, and not form the theory first and then try and find facts to fit it. This is the pit which scientific men too often dig for themselves and fall into. The first step, after forming the theory, is to test its truth by renewed observation and by careful experiment, which Huxley calls an artificial observation of facts. The art of experimenting is not to be learned in a day, but should form the apprenticeship of the engineer. When a man, having formed a plausible theory, and having found it corroborated by experiment, suddenly runs against some obstinate beast of a fact that upsets it altogether, what shall he do? Shall he abandon the theory, ignore the fact, or go on patiently looking for newer facts? This is the test which shows whether he is imbued with the true scientific method or not. Cervantes showed great knowledge of human nature when he described Don Quixote breaking his helmet by a blow of his sword, and then patching it up again. The Don raises his sword to strike it again, pauses, drops his sword, and finally concludes that the helmet is strong enough after all.

True science begins with the use of mathematics and the invention of instruments of precision. Astronomy began to be a science with the invention of the telescope, and engineering with the invention of some kind of leveling instrument. A science becomes complete when its prediction can be verified. Electricity became a complete science when Franklin's prediction that his lightning rod would protect from the electric flash was found to be true. Engineering became a science when the first stone arch carried its load in safety. How shall our profession be instructed in the scientific method? In past times everyone had to find out for himself as best he could.

Fortunately we have now an abundance of technical schools, in which those intending to be engineers can be trained both mentally and physically in the very things that they ought to know. They can

* Sodium hydrate is melted in an iron pot, and a carbon cylinder is immersed in the molten material. Air in fine jets is blown through the hydrate. The oxygen from the electrolyte combines with the carbon, and an electrical current results from the direct oxidation of the carbon, without any material accompanying generation of heat. The supply of air constantly regenerates the hydrate by supplying fresh oxygen to replace that which has entered into combination with the carbon.

be trained in mathematics, and the physical sciences, while in chemical, physical, and electrical laboratories they can be taught the essential arts of experimenting. They learn the use of delicate instruments, and the art of drawing. Already has been felt in our profession the great influx of young men, trained and cultured in all these things. These schools rank as high, and some think even higher, than the older schools of law and medicine. It must be clear that the value of the training and instruction which these schools give depends greatly upon the character of their professors. We sometimes hear sneering remarks upon the engineering of professors, when some of them have attempted to design and execute work for which their experience had not qualified them. Clearly, this is the fault of the individual and not that of the class, who are a most able, competent, learned, and painstaking set of men. We should look upon them with the highest respect, and aid in every way in helping them to keep in touch with the profession, by sending them copies of our latest plans, specifications and photographs of executed works. We should not be afraid, also, to tell them of our mistakes (for the best of us are but mortals), and aid in filling that vast and useful volume which should contain what we do *not* know about engineering.

Looking at the great numbers of young men who are yearly graduating from the technical schools and entering the ranks of our profession, the fear has sometimes been expressed lest there may not be room for all. Let us look at the great number of divisions into which engineering, following the general law of evolution has become, and is still becoming, specialized, and see if there is not yet ample room. Civil engineering is divided into structural, mechanical, electrical, metallurgical, hydraulic, mining, agricultural, chemical, sanitary, municipal, highway and railway engineering. These classes are again subdivided; as hydraulic engineering into canal, harbor, water supply, storage, and irrigation engineering. Railway engineering is divided into bridge, foundation, track, signaling, locomotive and car engineering.

Such specializations come constantly to meet new wants. Thus we now see developing a special class of engineers created by the great value of land in cities, calling for very high buildings, and requiring experts to design their metallic frames and their foundations, made complex by their limited spaces and the necessity of avoiding encroachment on others. The general principles of engineering govern all these special applications, and may best be described in the words of Bacon: "Nature can be controlled only by obeying her laws."

Some persons confuse civil engineering with structural engineering. We read in the prospectus of one of our technical schools that courses are given in mechanical, mining and civil engineering. What is meant is structural engineering, or the art of constructing earthworks, piers, walls, dams, bridges, roofs, viaducts, etc. The term civil engineering has a much broader meaning, and comprehends all engineering except military and naval. It includes all useful works of sufficient magnitude and intricacy to require scientific method, knowledge and skill in their construction. The civil engineer's true position is similar to that of the architect, who commands the services of many different professions and handicrafts. Mechanical and electrical engineers and many others aid him in their several lines, but from him comes the comprehensive design, and he alone is the director-general of the works.

Such is the position claimed for civil engineers in Britain and on the Continent of Europe. The members of our Society should claim it here, and not only claim it, but show that they are capable of filling it. There is but one way in which they can do this, and that is by showing themselves masters of scientific method and knowledge. In no other way can the vast interests committed to their charge be safely protected. If the engineer has it, and knows how to use it, we shall hear of no more bridges breaking down, dams being washed away, foundations settling, or guessing at the cost of ship canals, those scandals of the profession.

The war between theory and practice has nearly come to an end. We now recognize that either without the other is not of much value. The practical man is one who has had experience in his own special line, and within his narrow limits, he is not likely to make mistakes. The theoretical man without experience is a dangerous guide. Hence we wisely treat the young man, trained only to the schools, as an apprentice, and make him follow instructions until he gets experience. When he has got it, he rises very fast, and soon becomes a master, and in the race of life passes the "rule-of-thumb" man. This is the report which we get from the officers of the railways and manufacturing corporations, and from chief engineers, all uniting in preferring the trained man.

The progress of civil engineers in the future will be far greater than it has been in the past. Civil engineers will take a much higher rank in public estimation than they have done, and greater emoluments will follow.

Engineering is the great creative science. It has created a new nature governed by Nature's laws, but one which would soon disappear without the support of the engineer. Just as art creates new bodies of men and women, fairer than those of Nature, and literature creates new characters, as alive and real as the people we meet in the streets, so does engineering create its new world. The locomotive is a draft horse, excelling in power, speed, and endurance a thousand of Nature's build. The bicycle is a faster saddle horse, eating nothing but a little oil, and asking only to be kept clean, and that its circular hoof shall be cured of punctures. The aviation machine, if we get it, will be an improved bird; the ocean steamer is a fish set at work. The idle river rolls on for thousands of years. The engineer harnesses it with his turbines and makes it work, either on its banks or at a distance, through dynamos and wires. These very electric wires by which we transport sound and energy are nothing but an extended system of nerves. Great deserts lie uninhabited. The engineer builds his irrigating dams and canals, and the desert blossoms like the rose, with every variety of flower, fruit, and grain. The dreadful pestilences which once devastated the earth have been almost stopped by the sanitary engineer. The engineer has even shrunk up the world itself with his railways and telegraphs. Magellan took over a thousand days to go around the world; when the Siberian railway is completed it can be traversed in less than fifty. Shakespeare, with his wonderful prevision, makes Puck say that he will put a girdle round about the earth in 40 minutes. This was nearly accomplished at the electrical exhibition in New York on May 16, when telegrams were sent half around the world and back, a distance of 27,500 miles, in 47½ minutes.

I have thus attempted to trace the evolution of the engineer from the early days when he knew but little (but what he did know he knew well) down to the end of this nineteenth century, whose wonderful achievements in all branches of science have made it absolutely necessary that the engineer should be as thoroughly equipped with scientific method and training as are those who have made these discoveries.

Standing as I do, near the close of my professional career, I address not only to the members of this Society, but to all engineers wherever they may be, this solemn warning—you cannot afford to be ignorant. When science—the accurate knowledge of what others have done—and experience—the knowledge of what we ourselves have done—are united in the same person, then we may truly say that we have seen the evolution of engineering from a craft to a profession.

Lead vs. Iron for Supply and Vent Pipes, from a Plumber's Point of View.

By Mr. William Eccles, of Portland, Oregon.

If we consider the question as an engineer would when seeking the most suitable material for his purpose, and divest our minds of all prejudice and consideration of how it will affect our individual interest as plumbers, or the business in general, we will sooner arrive at correct conclusions. If it is truth we are seeking, and not specious argument to bolster preconceived notions, we certainly do so.

In past times, lead was used by plumbers almost exclusively for water pipes and other purposes. It was the chief material a plumber was called on to use; and it was necessary for him to be most skilled in working, to be a success in his business. It was almost considered the only metal fit for that purpose.

Now we find it practicable to fit up the largest buildings in the most desirable manner, with the finest open work, and not use an ounce of lead pipe. The tendency of the demand at the present time is for substitution of other metals in preference to lead in the plumbing business. This tendency is the verdict of public opinion that condemns lead, and relegates it from the position of primary importance to a secondary one in the plumbing business. We may grieve at this tendency, but it is useless for us to kick against the progress of the times. It is better that we adapt ourselves to the situation, keep in line with all improvements, and not attempt to impede them because they necessarily dispense with the skill we have acquired.

Lead pipe (which was sometimes tinned inside) was formerly considered the most suitable for the conveyance of water from the mains to all vessels used for domestic purposes. It certainly answered the purpose well. The charge of lead poisoning was sometimes laid to the use of these pipes, but few cases were ever proved. The percentage of people using this pipe suspected of suffering from lead poisoning was so small as to be of little importance.

To the Pacific Coast iron pipe came with the early gold seekers, and was probably used by them as water pipe, because it required less skill to join and lay it. Black iron pipe was soon found to be useless on account of rusting, but galvanized iron pipe answered better, and was first introduced in small houses for conveying cold water only, and was not considered suitable for hot water at all. As experience showed no objectionable feature in this material, it began to be used in better houses, but for many years iron was used for cold and lead for hot water. Gradually the use of galvanized iron pipe extended for hot water, until now it is almost the only kind used. Forty years' use on this Coast has demonstrated that for supply pipes galvanized pipe is well adapted. The zinc coating has proved a thorough protection which makes it very durable.

In comparing the several advantages that lead and galvanized iron pipe have when used for water supply, we find that, galvanized iron pipe being harder, it is less liable to be damaged by accident, as it is able to resist such accidents as nails being driven against it and the gnawing of rats.

Being stronger it requires less support and is never found hanging in festoons. It is seldom broken with fair usage, when once covered up in good condition. It seldom requires any repairs, except when it is burst with frost. It is not injuriously affected by rapid changes of the temperature of the water it carries in any degree above the freezing point, as is lead pipe if allowed room for expansion.

The cost of galvanized iron pipe and the labor needed for its use are less than for lead pipe. With the introduction of nickel plated supply pipes for connections of open work, there disappears the last obvious advantage of lead for supply pipe. Lead pipes are often taken out of houses, to be replaced by galvanized iron pipes, but never the reverse on this Coast.

If this be the result of the experiment of using galvanized iron pipe for supply pipe in a new and venturous section of the country, it only indicates what will be the result in older and more conservative sections of the country. We find plumbers in Eastern cities getting alarmed at the increased use of galvanized iron for supply pipe, and claiming in the trade papers that it becomes worthless in three or four years; that it rusts at the ends and at other exposed places, and is generally no good. Forty years' extensive experience with the use of it on the Pacific Coast demonstrates that such is not the case. The continued growth of its use from a modest introduction of it as a cheap and convenient substitute, to its present position, when it has driven lead supply pipe entirely out of use, and that too in face of the hostility of the men who had to work it, proves that it must have merits of no small degree.

When used as waste pipes, iron pipes do not have the same advantages they have as supply pipes. Wrought iron pipe unprotected by covering is not suitable for vent pipe, and should be discarded for the reason that it rusts quickly internally, which rust soon begins to fall from the vertical portions and closes the bottom of the pipe. Galvanized iron pipe is better, but it will not withstand the action of sewage or sewer gases, and therefore is not reliable.

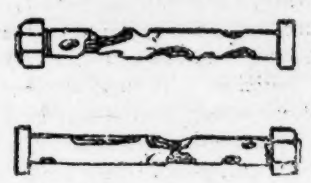
Iron pipe dipped in asphaltum and thus protected has no known weakness, and the great success of the adopting of iron dipped pipe for soil pipe would justify us in expecting equally good results from the general adoption of such pipe for sewer ventilation.

Lead pipe for ventilation has many advantages to recommend it if properly supported and protected. Lead pipe is capable of resisting all chemical action of sewage or gases, and, not being exposed to great changes of temperature, there is little danger of breaking by contraction and expansion, as it is sometimes the case with waste pipes which convey hot water. The smoothness of the interior of lead pipe and its gentle curves, make it most efficient and desirable on account of the small friction which it offers.

The Corrosion of Iron by Raw Tar.

Mr. F. J. R. Carulla, in a paper before the Nottingham (England) Section of the Society of Chemical Industry, on the matter of the corrosion of iron by raw tar, said:

Coal or gas tar is very extensively used for protecting from rust iron surfaces exposed to the weather, especially in chemical works, where the atmosphere is more than normally destructive of the metal. This is the reason for bringing before you a remarkable example—or what appears to be one—of the danger that the careless or ignorant use of raw tar as a substitute for paint may entail. The two bolts here exhibited, originally 12 inches by 1⅛ inch thick, which are so thoroughly corroded as to present the appearance of having been soaked in some dilute acid for a considerable time, were found in this condition when taken out of the valve boxes of a pump through which only water from



a well for the general supply of the works had been passed. The bolts, which act as stops to prevent the excessive rise of circular india-rubber valves, were always completely immersed in the water. The only explanation of this corrosion that has been arrived at is that tar residues known to exist on the surface soil have communicated this undesirable property to the water in the well. A chemical examination confirms this. The water was found to be basic, which might be expected from its strong smell of naphthaline or gas liquor. It yielded on analysis;

Total solids at 110°.....	82.00	parts per	100,000
Free ammonia.....	0.43	"	"
Albuminoid ammonia.....	0.01	"	"
Chlorides, expressed as chlorine...	12.20	"	"
Carbonates, expressed as $CaCO_3$...	22.00	"	"

This water has eaten into iron to the extent seen on the surface of these bolts, which show indentations in places exceeding ⅛ of an inch in depth. That this corrosive action is due to something communicated by the tar would appear to be indicated by the fact that similar bolts in a pump at the same works used for raising tar, and that only, also show corrosion of a similar character, although not quite so pronounced. The bolts in another pump, lifting river water in the same place, show no signs of corrosion, which goes some way to indicate the common origin of the damage in the two other cases.

From a consideration of the analysis of the water, given above, one may reasonably suspect that the presence of ammonium chloride, a considerable constituent of some gas liquors, and which, therefore, must be frequently present in crude tar, may contribute to the corrosive properties of this water.

The remarkable character of the corrosion, which is so much localized in various places, leaving much of the surface of the bolts almost untouched, suggests the formation of galvanic couples at a number of points, in the neighborhood of which the whole of the action has taken place. The oxide of iron that is sometimes present in wrought iron, in the form of slag left between the laminæ of which such iron is composed, may account for this peculiarity. Whatever the exact explanation may be, the examples before you certainly impress one with the necessity for neutralizing the cause of this corrosion before using crude tar as a protection for iron surfaces. Cases could be cited of gasholders that have been quite damaged by having been coated with raw tar without preparing it in any way. A note abstracted from a German source, and given on page 480 of the *Journal of the Iron and Steel Institute*, No. II., 1892, is worth quoting, as it describes how tar should be prepared for use on iron, and is otherwise instructive: "Raw tar is not adapted for use in coating iron. The coating produced rapidly scales away and destroys the metal, the action being due to the carbolic acid which is present in the tar. If this tar, however, is heated with 2 or 3 per cent. of lime, to neutralize the acid, it may afterwards be used without injury to the iron, and at the same time give a satisfactory coating to the metal."

It will not escape notice that carbolic acid is here given as the injurious constituent, whereas the contaminated water here referred to is of a basic character. As ammonia is also generally present in tar, it is not unreasonable to suppose that lime possesses a permanent neutralizing power for the acid that the volatile alkali does not possess. It is almost superfluous to add that the carbolic acid so injurious to iron is the very thing wanted for the protection of wood. Therefore, when coating with tar a railway tank wagon, for example, the proper method would seem to be, first to coat the ironwork with tar that has been heated with lime in the manner described, and after that to coat the wooden framework with carbolic acid.

THE Court of Appeal, Canada, has rendered a decision in the matter of the appeal from the lower courts by the Consumers Gas Company, of Toronto, over the right of the city to tax the mains and pipes of the Company. The decision was against the Company, the Court of Appeal ordering that the appeal be dismissed.

Qualifications for Municipal Engineering.

[By Mr. Chas. Carroll Brown, in *Paving*.]

The city engineer ordinarily has charge of the construction of sewers, streets and bridges, and has some supervision of the laying of gas and water pipes, electric conduits and the like. In some cities he has supervision over the plumbing of houses and buildings and their sewer connections; in other cities the water supply is under his charge, though usually it is under a separate department; in others he has charge of the repairs and cleaning of streets, and even in some cases of the construction and repair of public buildings.

The field of the sanitary engineer overlaps this field, but he is usually supposed to have a training which enables him to make complete plans for sewerage and drainage, water supplies and like problems, and in some cases he is not so familiar with methods of construction as the more practical city engineer. In the past, and to a large extent at the present time, the city engineer, in the ordinary small city, and in not a few of the larger cities, is a man who has worked up from subordinate positions and has not received any more of a technical training than can be obtained from the process of "learning to do by doing," and therefore it is frequently necessary to call upon outside help whenever any special work must be laid out, such as a sewerage system or a material increase in such a system, an expansion of a water supply, a new building or a large bridge. That such help is not called for as frequently as it should be is evidenced by the long list of blunders of so-called city engineers, as well as by committees of the city council, as will be described later. The sanitary engineer, who is a very modern product in this country, has received a technical training and practice in subordinate positioms in preparing plans for systems of sewerage, water supply, etc., and is fitted to take up a large class of problems on which the ordinary city engineer needs help.

It is painfully evident that there is great need of educated men to fill positions as city engineers, and that the number of places really needing such men is vastly greater than the number of men capable of properly filling them. There is just one trouble and one reason why the places do not call loudly for the men they actually need. The position of city engineer, in too many cases, is subject to the demands of politics. Unless the city is continuously in control of one party, and the engineer is enough of a politician to keep himself "solid with the party bosses," the tenure of office is too precarious to draw good men at the present small salaries. Then, it is too often considered necessary to appoint a local man, no matter if he has no ability, when well qualified men can be secured from other places. There is no small amount of wire pulling by many men in the field of sanitary engineering also, for that work is also somewhat affected by politics in many cases. So long as positions requiring technical knowledge, which is comparatively hard to find, are given as rewards for party work by the applicant for the position or his friends, we may expect the great majority of the holders of such offices to be either in some degree incompetent, or as unstable as the offices they hold, only to be found in them for the expe rience to be gained or until a fair opportunity offer for more permanent and more congenial employment. The great American desire for change, which has its most objectionable manifestation in the sentiment in favor of "rotation in office," is a force which tends very strongly towards the continuation of the present system.

There are very many instances of engineering work, especially in the smaller cities, planned and actually supervised by a committee of the common council, the duties of the engineer being restricted to the running of levels, making of surveys and maps, setting of stakes and measurement of the completed work. In other words, he acts the part of an instrument man and draughtsman only. Where this is true, the custom has probably arisen because the man appointed engineer was only able to do this class of work, and a man of no engineering training, but with good common sense, could do better engineering than the engineer. The pay of this class of engineers is very small, and the principle has been so thoroughly ground into some city officials that it is often impossible to improve matters until some great blunder is made and a great unnecessary expense is incurred, and it is found necessary to get some help from outside. In revising the sewer system of a certain city, some long sewers were found of the same diameter throughout, say a 3-foot brick sewer, when a 10-inch pipe would have been sufficient for the upper end, and a 4 or 5-foot sewer would have been none too large for the lower end. This sewer was planned by a council committee to run indefinitely, and was cut off when it got so near the surface of the ground that it could not be extended further. In another city the council committee ignored a general plan for sewers, and proposed to construct a sewer which, if later continued on the line proposed, to do all the work desired by the committee, would have been 3 or 4 feet above the surface. In both these cases an engineer of full information and adequate training would have had sufficient standing to carry the plan the right way and show the council the fallacies of their propositions, but an engineer who was considered by the committee as of no more value than a clerk could not do it. There is a vast field for missionary work open here.

Engineers have a great work to do in educating public sentiment to the point of demanding a change in the present methods. And they should not be backward about it. The engineer is usually too modest for his own good or that of his profession, where the general public is concerned. No matter if people do say he is talking chiefly for his own benefit; that is only partly true, and such talk does not prevent the doctor and lawyer from agitating reforms beneficial to their professions as well as to the people at large. To be sure, there are many doctors and lawyers in the community, and but few engineers. That is all the greater reason why the engineer should talk, judiciously, loud and long. When the change comes, and it will come largely within the lifetime of present readers, the greatest field for engineers will be that of municipal engineering. Until it comes, the field of sanitary engineering will be an increasing one. It will be very easy to step from the one to the other at any time that the change comes for any particular place. Those who have received the training of the sanitary engineer and are holding subordinate positions in the employment of sanitary engineers of large practice, and the army of men with small practice, will be best fitted to step into the good places in municipal engineering, when they become desirable from their permanency and amount of salary.

At this time, therefore, there is need for courses of study in our technical schools, which will give special training in municipal and sanitary engineering. The fundamental work is the same as that for all engineering courses; it is only necessary to pay more attention to certain branches of the work and add some special studies.

I am a strong believer in the value of a good general training for the engineer as well as for the lawyer and the physician. His profession is as dignified as theirs, more valuable to the community at large, quite as learned, and in all respects as deserving of high position in the world's opinion. If it has not heretofore held this position, it is largely because too many of the individuals claiming to belong to it have not had the training, either general or particular, which the profession should demand. A vast improvement has been observed in the last few years; but much greater improvement is possible. The profession will never take the high position that rightfully belongs to it until its prospective members recognize the necessity of as thorough a general training as is required for other professions. This training should form the basis for the strictly technical work, which corresponds to the work of the medical, law or divinity school. I would add to the ordinary engineering course, therefore, at both ends, making it give first, a better general training; second, the general technical work; third, the special work in municipal and sanitary engineering.

The lack of a general educational training among engineers has been the great cause for the low estimation in which the profession has been held. Leaving out the cases where politics govern, why are lawyers, successful business men and contractors, chosen to serve on commissions where nearly all the questions to be considered are purely engineering questions, and the engineers ignored completely? It is not because the engineer's knowledge and special training are not needed, because the engineer is at once called in to prepare the engineering features of the case for presentation to the members of the commission and to the public. He acts, however, almost invariably as a subordinate, carrying out the definite orders of his superiors, the commissioners. Where he is sufficiently valuable as an engineer the commission is glad to take his judgment of the case throughout, and present his solution of the problem in hand as their own or as receiving their full approval. Why, then, was he not chosen in the first place as a responsible member of the original board? The answer to this question, and the reason for the subordinate positions too often taken by the engineer throughout, are to be found, I think, in the fact of the too strict confinement of the engineer in his education to the technical studies of his profession. He becomes an adept in these, and when called upon is able to make his mark in solutions of problems embodying great technical difficulties, but, unless he has by his own efforts supplied the deficiencies in his early education, he is all too often unable to take his proper place in the world's work, because he is unable to get above the technicalities and see the problems in their general relations, or be able or willing to express the truth he possesses at the proper times and places to put him where his fitness deserves, relatively to other public spirited citizens.

The lawyer, from the nature of his profession, is obliged, as a rule, to become familiar with and to express himself freely and without special preparation upon a great variety of subjects. He will, therefore, in the course of business fill up many deficiencies in his early training, without taking special thought of them. The preacher is almost as certain to do this, if he has any public spirit or any range of vision beyond the narrow walls of his own church. The successful physician is the one who is in touch with the questions of the hour and holds himself in readiness to lead in his direction when opportunity offers. The successful engineer must do the same. His opportunities are much greater than those in any other profession, excepting possibly the law, but his daily experience is not such an aid as that of the lawyer is to him. The engineer must, therefore, exert himself to a greater extent, and his early training must be fuller and more rounded, just because his opportunities for filling up deficiencies in lines of thought of general value are so much less in his after experiences.

The fact is, that the man who expects to make a good lawyer, physician or preacher of himself, comes with good preparation and takes his four years in college, three or four years in a professional school and one or two years or even more in hospital or in subordinate office positions, while the engineer is satisfied with as little preparation for college as possible, and with four years, or at most five, of work made as special and technical as possible; with general culture studies cut to a minimum, and then enters the field fitted, he fondly hopes, for "anything in the engineering line." And I hear some college professors, who ought to know better, defending this course, saying, among other things, that the young man gets into life late enough as it is. I can not see the economy of "saving" two to four years at the beginning of professional life at the expense of a "horizontal reduction" extending through life, in the earning capacity, and especially in the capacity for doing one's share of the world's good work.

Comparative Efficiency of Pintsch and City Gas.

The *Railroad Gazette*, in acknowledging the receipt of a copy of a report made by Mr. P. H. Brangs, Electrician of the Delaware, Lackawana and Western Railroad Company, of an investigation of Pintsch gas, compressed city gas, Pintsch's lamps and Gordon-Mitchell lamps, as used for car lighting, says that Mr. Brangs first takes up the cost per 1,000 cubic feet of Jersey City gas compressed and supplied to cars, on a basis of a maximum of 40,000 cubic feet per day and an average of 30,000. He starts with city gas at $1.50 per 1,000; allowing 20 per cent. for loss by compression and leakage raises the cost to $1.80. The cost of compressing he finds to be $0.945. This is made up as follows:

Labor, compressing	.18
Labor, charging cars	.18
Repairs and renewals to compressing, storage and supply plant	.12
Interest on plant	.14
Depreciation	.14
Coal for compressing (106 lbs. per 1,000)	.16
Water for compressing (1,500 lbs. per 1,000)	.025

It will be remembered that Messrs. Denton and Chandler, in their investigation for the Lehigh Valley, arrived at $1.003 as the cost of compressing and charging.

Mr. Brangs then takes up the matter of the value of the different gases and lamps for illumination. These tests were made in a passenger car fitted up for the purpose. The interior finish of the car is light, being natural oak. The Pintsch gas used was the regular product of the road taken from its service pipe lines at Hoboken. The city gas was got from the Pennsylvania Railroad Company, at Jersey City, and taken from the regular service pipe lines at the Pennsylvania station. The tanks were filled, one to a pressure of 19¾ atmospheres, the other to 19 atmospheres. The lamps tested were, for Pintsch gas the standard 4-flame with No. 40 tips, also the same lamp using only three burners with No. 80 tips; also the Pintsch Argand lamp No. 1. For the city gas the Pennsylvania Railroad standard Argand lamp for burning city gas was used, otherwise known as the Gordon-Mitchell.

The city gas was supplied to the lamps under a pressure of 21 lbs. per square inch in the pipe leading from the regulator to them, this being the practice. The "drop" of the 3-flame and 4-flame lamps was 24 ins. from the ceiling. That of the Argands was about 21½ ins. The adjustment of all lamps for the consumptian of gas is what would be obtained under normal conditions of train service. During the tests all light from without the car was entirely excluded.

Tests were made to determine the actual *general illumination* of the car by each system of lamps; also to determine the *candle powers* of each style of lamp used.

The tests for general illuminating were two in number, given below as *A* and *B*. Test *A* was a new and original method of comparing the illuminating values of the systems directly without referring to candle power. Test *B* was made by determining the illumination from each system in terms of a standardized burner and comparing the results. These tests were carried out as follows:

(*A.*) The car was fitted so that two Argand lamps burning city gas were in one-half of the car, and two Pintsch Argand lamps No. 1 burning D., L. & W. gas were in the other half, and afterward with two D., L. & W. standard lamps with three No. 80 tips in place of the Pintsch Argands No. 1. A black curtain was hung from the ceiling at the middle of the car, completely dividing the car. A photometer disk was arranged in an aperture of this curtain, placed 50 inches above the floor level, this height being about the average of a passenger's eyes when seated or standing. If the illuminating powers of the lamps were equal, the disc would so indicate; but in each case the light from the Pintsch gas was decidedly the stronger. To find out the relative amounts of light from the two sets of lamps which were being compared, slides parallel with the disk, with a determined light obstructing value, were interposed, thus cutting off the light from the disk until the illuminations on both sides were equal.

The results showed that the Pintsch Argand No. 1, burning 3.5 cubic feet of Pintsch gas per hour, gave 2.04 times as much light as the city gas, burning 7.85 cubic feet of gas per hour; or, the Pintsch gas gave 4.59 times as much light per cubic foot as the compressed city gas did.

The results with the D., L. & W. standard lamp, with No. 80 tips, burning 3.89 cubic feet of Pintsch gas per hour, gave 2.48 times as much light as the city gas, burning 7.9 cubic feet per hour; or, the Pintsch gas gave 5.04 times as much light per cubic foot as the compressed city gas.

(*B.*) The method *B* was the same as devised by Dr. W. H. Chandler, of Lehigh University, and used in his tests for the Lehigh Valley Railroad Company. A curtain was hung midway between the first and second lamps. The photometer disk was located in an aperture in the curtain, and 50 inches above the floor.

The illumination from the second, third and fourth lamps was measured, readings being taken with the photometer disk at the angles of 90°, 75° and 60° with the horizontal.

The results showed that the Pintsch Argand No. 1 burning 3.48 cubic feet of Pintsch gas per hour gave 1.65 times as much light as the Argands burning 8.44 cubic feet of city gas per hour; or the Pintsch gas gave 4 times as much light per cubic foot as the compressed city gas did.

The results with the D., L. & W. standard lamp with No. 80 tips, burning 3.71 cubic feet of Pintsch gas per hour, gave 2.16 times as much light as the Argands, burning city gas at the rate of 8.44 cubic feet an hour; or the Pintsch gas gave 4.93 times as much light per cubic foot as the compressed city gas did.

The D., L. & W, standard lamps, with four No. 40 tips, burning 3.36 cubic feet of Pintsch gas per hour, gave 1.39 times as much light as the Argands, burning 8.44 cubic feet of city gas per hour; or Pintsch gas gave 3.5 times as much light per cubic foot as the city gas.

In the *single lamp or candle power tests* the second lamp was the one measured in each case, and readings were made at angles of 30°, 45° and 60° below the horizontal. The methods employed were those usually followed in tests of a similar character, and are explained in detail in tables. The results were as follows:

The D., L. & W. standard 4-flame lamp burned 3.4 cubic feet of gas and gave 34 candle power. The same lamp with 3 No. 80 tips burned 3.64 cubic feet and gave 49 candle power. The Pintsch Argand No. 1 burned 3.55 cubic feet and gave 48 candle power.

The city gas Argands burned 8.3 cubic feet an hour, and gave 23 candle power.

The average results of all tests showed the percentage of light per cubic foot of gas burned to be as follows:

	Per cent.
D., L. & W. 4-flame, Pintsch gas	73.3
" " lamp 3, No. 80 tips, Pintsch gas	100.0
Pintsch Argand, Pintsch gas	95.7
City gas Argand, city gas	20.7

The highest relative efficiency of Pintsch gas as compared with city gas found by Mr. Brangs, as stated in detail above, was 5.04; that is, the Pintsch gas gave that many times as much light per cubic foot as the city gas. The lowest relative efficiency was 3.5. The ratios determined by Messrs. Denton and Chandler, as stated in the article to which we have referred above, were 1 to 3.44, 1 to 3.78 and 1 to 4.4.

Mr. Brangs makes the total cost of Jersey City gas compressed and supplied to the cars, $2.745. Using his ratios of efficiency as given above this would be equivalent to Pintsch gas at from $9.61 up to $13.83.

Accompanying the report are a number of detailed tables which we do not reproduce, as the results are given above in sufficient detail for practical purposes. If anyone wants to study the particulars of the tests, presumably he can get a copy of the report on application to Mr. Brangs.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. C. F. ADAMS, the clever President of the Portland (Ore.) Gas Company, has been elected Second Vice-President of the Oregon Railway and Navigation Company.

MR. H. C. SLATER, son of Mr. A. B. Slater, of the Providence (R. I.) Gas Company, has accepted a responsible position with the Milwaukee (Wis.) Company.

THE reduction in gas rates at Norfolk, Va., and the new management of the City Gas Company, of Norfolk, have been announced. The gas rate concession is to take effect on the July consumption. The gross price is to be $1.50 per 1,000, instead of $1.60 as before, and a discount of 20 cents per 1,000 will be allowed if the bills are paid within the first five working days of the month in which the gas is consumed—a net rate of $1.30 per 1,000. Some improvements will be introduced at the works, with a view towards giving the consumer the best possible service at a minimum cost. Services will be laid, meters will be set and connected, etc., at prices not to exceed cost. Arrangements have also been made under which consumers can purchase gas stoves at exact cost to the Company.

THE following letter from Mr. E. H. Jenkins is in reply to the letter of Mr. T. A. Bates, of La Crosse, Wis. Mr. Bates' communication will be found in the JOURNAL for June 15th, page 958:

COVINGTON GAS LIGHT COMPANY,
COVINGTON, KY., July 4, 1896.

To the Editor AMERICAN GAS LIGHT JOURNAL: I did not answer the letter from Mr. Bates for the reason that I thought, from the way the figures were given, anyone could see that they were in error. What I intended to say was: Temperature at station meter, 75°; temperature of water in holder, 45°—a drop of 30° between station meter and inlet to holder. The fact that I got the figures mixed must have been due to the "ozone" of Lookout Mountain. Sincerely yours, E. H. JENKINS.

THE proprietors of the Jefferson City Gas Light Company, of New Orleans, La., have declared a semi-annual dividend of $2 per share, payable the 13th inst.

JUDGE SANBORN, of the United States Circuit Court, has issued an order appointing Mr. Charles S. Benson receiver of the properties of the St. Cloud (Minn.) Gas and Electric Company. The Court also authorized the receiver to apply to the District Court, of Stearns county, in the case of John D. Sullivan against the St. Cloud Water, Light and Power Company, for possession and control of all property independent of his possession and control of the Water, Light and Power Company.

MESSRS. HENRY M. WHITNEY, Henry F. Dimock, Jas. Phillips, Jr., Albert N. Parlin, George B. Harvey and John M. Bailey, acting as a majority of the incorporators of the Massachusetts Pipe Line Company, have issued notice that the first meeting of the incorporators will be held in the office of the Dominion Coal Company, 95 Milk street, Boston, at noon of next Wednesday, for the purpose of "organizing said corporation, adopting a code of by-laws, electing officers and transacting such other business as may be brought properly before the meeting."

TO-MORROW the Board of Gas and Electric Light Commissioners of Massachusetts will hold a hearing for the purpose of taking testimony over the points in dispute between the authorities of Milbury and the Milbury Electric Light Company.

A CORRESPONDENT at Rochester, N. Y., writing under date of the 2d inst., says: "A new page is to be written in the history of the Rome (N. Y.) Gas Light Company. The interests for 29 years represented by Mr. J. D. Higgins, together with other interests amounting to about two-thirds of the capital stock, were, on July 1, purchased by Mr. Jas. Gamble, of New York, and others associated with him. At a meeting of the stockholders, held July 1, Messrs. J. D. Higgins, T. W. Singleton and Calvin Petrie handed in their resignations as Directors, and the Board was organized as follows: James Gamble, Woodville Flemming and Ralston Flemming, of New York, and Thomas H. Stryker, Wm. R. Huntington, John G. Bissell and H. G. Utley, of Rome, being named for the Board. Since its organization in 1852 the capital stock of the Rome Gas Light Company has until now remained at the original sum of $35,000. From the earnings of the Company additions and improvements, notably the electric light plant, have been made, so that the actual value of the Company's property largely exceeds the amount of the original capital. Hence the stockholders, at the meeting July 1, pursuant to public notice, voted to increase the capital stock to $100,000. The Company is free from debt, and the Directors were authorized, in their discretion, to issue such portion of the $100,000 of bonds as might be required for contemplated extensions and improvements. Mr. Gamble's plan for the immediate future is understood to contemplate the introduction of improved methods in the manufacture of gas, so that it may be cheapened, and used not only for light but for fuel, especially for cooking and for intermittent heating. The intention is to extend the gas mains wherever the demand for gas is likely to warrant the expenditure, and the purpose will be to demonstrate to people in and outside of the present gas limits that they can use gas to their advantage. The electric light and power plant will receive such attention as it may require, and if it is found that the improvements can be made they will be introduced. It is to be expected that Mr. Gamble, who is not without experience in gas matters, will introduce a vigorous management. He will spend some time here, especially at the outset, in supervising the installation of improvements and establishing the new management. The citizens of Rome generally will welcome this news in relation to the Gas Company, and they will welcome the management of Mr. Gamble and his associates on the plans laid down. Anything that promises increased facilities, advantages and benefits is to be hailed with approval and encouragement."

THE proprietors of the Hazelton Boiler Company report the following recent sales of boilers, aggregating 2,450 horse power: Rochester (N. Y.) Gas and Electric Company (8th order), 500-horse power; Lambertville (N. J.) Rubber Company (3d order), 200-horse power; Goodyear Rubber Co., Middletown, Conn. (3d order), 150-horse power; Bristol (Conn) Electric Light and Railway Company (3d order), 200-horse power; Equitable Gas Light Company, New York, 500-horse power; Pettebone Cataract Paper Company, Niagara Falls, N. Y., 250-horse power; North Adams (Mass.) Gas Light Company (3d order), 150 horse power; Newton Falls (N. Y.) Paper Company, 250-horse power. They have also recently completed contracts with the Capewell Horse Nail Company, of Hartford, Conn., and with Messrs. P. and F. Corbin, of New Britain, Conn. The Company also notes that nearly all of its recent orders are based on the earliest possible delivery, and that many of its recent sales have been made to old customers who are now enlarging their plants. The original boilers sold to these customers have been in constant operation for from eight to ten years, without repairs, still carrying high pressures and giving the same true results as when new. This, together with the fact that the Hazelton Company has made various improvements in the construction and selling of its boilers, thus increasing their efficiency and improving their appearance, makes the sale of the Hazelton boiler a very mueh easier matter than was the case formerly.

MR. HENRY C. KELSEY, President of the Newark (N. J.) Gas Company, is at his desk again, very much benefited by a short sojourn in Europe.

MR. W. H. FRITCHMAN, of this city, who was concerned in the recent purchase of the Fishkill (N. Y.) gas plant, is our authority for the statement that that plant will be overhauled, both as to the generating and main systems. In the meantime we understand that Mr. W. R. Scofield will have charge of the works.

THE Welsbach Commercial Company, of Philadelphia, received, under date of June 20th, a letter from the "Societe Francais d'Incandescence par le Gaz, Systeme Auer," which says: "We take pleasure in informing you that in the process of infringement in which we have been engaged against Deselle, Boisellot, Scheurmann, and others, the Eleventh Chamber of the Tribunal Correctional has given to-day a judgment completely in our favor. We think we will be able to communicate to you during the next week the complete text of the judgment, the consideration of which will be of great interest, notably for

the definition it contains of the invention and the value of the anticipations."

THE Chicopee (Mass.) Manufacturing Company has announced a reduction in the gas rate. Under the new schedule the gross price is $2.25 per 1,000 cubic feet, with 50 cents off for prompt payment—within 10 days after the bill is rendered. The old schedule was $4 per 1,000 cubic feet, with a discount of 25 per cent. for prompt payment.

THE new gas rate at Cambridge, Mass., took effect on the 1st inst.

THE proprietors of the Arlington (Mass.) Gas Light Company have ordered a reduction of 50 cents per 1,000 cubic feet in the selling rate. The old price was $2.50.

AT a meeting of the Board of Directors of the Newton and Watertown (Mass.) Gas Light Company, Mr. H. L. Hovey, of Waltham, was unanimously elected President of the Company, to fill the vacancy occasioned by the death of Mr. Joseph N. Bacon. Mr. William F. Bacon was also elected a Director. The last named is a son of the late Joseph N. Bacon. The Directors also adopted a suitable minute to the memory of their late President.

MR. WM. COBB has been appointed receiver of the South Buffalo Natural Gas Company, of South Buffalo, N. Y. Justice Titus, of the Supreme Court, at the time of naming the receiver, also ordered that the Company be dissolved, the object for which it was formed having ceased to exist—at least so read the petition of the shareholders at whose instance the intervention of the Court was sought.

THE New Haven (Conn.) Post Office is to be again lighted by gas, a contract to that effect for the ensuing year having been entered into between the Government authorities and the New Haven Gas Light Company. Welsbach lamps are to be used. The New Haven Electric Company has been lighting the building for the last six years.

A CORRESPONDENT forwards the following under date of July 2d: "After much negotiation and consultation with the proprietors of the San Antonio (Texas) Gas and Electric Light Company, Mayor Elmendorf has finally closed a contract for the public lighting of San Antonio for the ensuing three years. The price agreed upon is 35 cents per lamp per night, for not less than 200, nor more than 250, arcs, to be maintained on a moontable schedule."

WE understand that Mr. G. N. Clapp, of Middletown, Ohio, has purchased the real property of the Wilmington (Ohio) Gas Light and Fuel Company, and will hereafter operate the same. It is also in the cards that Mr. Clapp will enlarge and improve the Wilmington plant, and beyond a doubt such a move would benefit it greatly. If there is anything in the gas business at Wilmington—and we believe there is—Mr. Clapp is just the man to bring it out.

THE Knoxville (Tenn.) Gas Light Company has awarded a contract for its coal supply to the Mingo Mountain Coal Company.

THE proprietors of the Ashtabula (Ohio) Gas Light Company have installed an ammonia concentrator on their works.

THE offices of the Jamaica Plain (Mass.) Gas Company have been removed from their former location on Gordon street to the new Sturtevant building, Bartlett Square.

THE following circular was recently issued by the proprietors of the Rockford (Ills.) American Gas Light and Coke Company:

"After July 1st, 1896, the price of gas will be $1.70 per 1,000 cubic feet. Discounts from this rate will be allowed to those who pay their bills on or before the 6th day of the month in which they are due:

Consumption per Month.	Discount per 1,000 Cu. Ft.	Net Price per 1,000 Cu. Ft.
400 to 2,900 cubic feet.....	20 cents.	$1.50
3,000 to 9,000 "	30 "	1.40
10,000 and over "	40 "	1.30

"For a consumption of less than 400 feet per month a charge of 50 cents per meter will be made, and if the bill is not paid by the 20th of the month in which it is due the supply of gas will be discontinued. This rule will be strictly enforced. Bills can be paid at the Manufacturers Bank, on the East Side, and at the Gas Company's office on the West Side. The Company desires to make the service of gas to its customers as complete as possible, and all defects when brought to the notice of the office will be remedied at once. Poor light is generally caused by the use of old or poor burners. By applying to the office you can get new burners free of cost. Your meter will be tested at any time, free of charge, on request, and in your presence if desired. The gas mains extend to all parts of the city and services will be run at reasonable rates. Gas stoves, fixtures, globes, etc., can be obtained at low prices. It is hoped that this liberal reduction of the price of gas will result in an increased use for light and fuel."

MR. W. R. ELLIOT, who returns to the direct service of the United Gas Improvement Company, on severing his connection with the Seattle Gas and Electric Light Company, of Seattle, Wash., was presented with a handsome piece of silverware by the employees of the Company.

MR. A. D. MEEDS, the official gas inspector for Minneapolis, Minn., reports that, during the month of June, the illuminating value of the gas supplied averaged 26.12 candles; the sulphur content (average of 5 tests) was 19.58 grains per 100 cubic feet; the ammonia content was 2.18 grains. The average maximum pressure was 2.47 inches; the average minimum pressure was 1.71 inches. The average consumption of gas per hour in the street lamps (average of tests on 100 burners, selected at random) was 6.08 cubic feet. One meter, on complaint of a consumer, was tested, and was found to be up to the legal requirement.

A SPECIAL despatch from Duluth, Minn., dated the 3d inst., is to the following effect: "O. C. and A. W. Hartman, representing the stockholders and bondholders of the Duluth Gas and Water Company, presented a proposition to the City Council to-night for the sale of the Company's water plant to the city and to furnish it with the money for the construction of the new pumping station at Lakewood and the laying of mains to connect with the Company's system. They offer the entire plant for $1,400,000, in payment for which they will take the city's 4 per cent. bonds to the amount of $1,200,000, while the city is to assume payment of the first mortgage bonds of the Company, bearing 6 per cent. interest and running about 10 years more, to the amount of $290,000. They will take the bond issue of $1,106,000 which the city is now offering for the purpose of building the new intake and connecting mains. They figure that the interest saved to the city by this offer will reduce the actual cost of the plant to $1,139,400. The city has been trying to sell 5 per cent. bonds, but the Company will accept 4½ per cent. bonds running 40 years. They also offer to reduce the price of illuminating gas from $2 to $1.50 per 1,000. After a lengthy discussion the Council practically rejected the Hartman's offer by laying it on the table and accepting the bid of E. C. Jones & Co., of New York, for the issue of 1,106,000 of 5 per cent. bonds for the construction of an independent plant."

THE Common Council of Philadelphia, Pa., seems disposed to enact the measure to authorize a loan of $8,000,000, to be devoted to public improvements in that city. It is understood that about 12½ per cent. of the moneys derived under the loan will be devoted to bettering the city gas works.

MR. WILLIAM MAINLAND, Manager of the Fond du Lac (Wis.) Gas Company, is very well satisfied over the way in which Supt. Murphy is conducting his end of the affairs of that corporation. It is proposed to extend the main system in a notable degree.

THE proprietors of the Cape Island Gas Company, of Cape May, N. J., have decided to abolish the charging of a meter rental. The price charged was $1 per meter per year.

THE Consumers Gas Company, of Toronto, has no immediate purpose of reducing the selling rate.

Incandescent Gas Lights for Lighthouse Illumination.

Mr. C. S. du Richie, in the course of a most interesting article on "Coast and Lighthouse Illumination in France," that has gone along in several numbers of *Engineering*, has this to say about the use and value of lightning flash incandescent gas lights in the special field of illumination treated upon:

The Auer Welsbach incandescent gas light was first (1895) experimentally applied on the French coasts in the Isle of Chassiron lighthouse (Bay of Biscay) in an ordinary first order (920 millimeters) optical apparatus, giving flashes one second in duration, at intervals of nine seconds. The results have been so satisfactory that the same system is in course of being extended to all the first order lights which hitherto

(*Continued on page* 55.)

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

EDITOR—Jos. R. Thomas, C.E.
ASST. EDITOR—T. J. Cunningham.
MANAGER—C. E. Sanderson.

PUBLISHED ON EACH MONDAY OF THE YEAR AT
No. 32 Pine Street, New York.

The JOURNAL is the official organ of the
NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
AMERICAN GAS LIGHT ASSOCIATION.
WESTERN GAS ASSOCIATION.
OHIO GAS LIGHT ASSOCIATION.
PACIFIC COAST GAS ASSOCIATION.
TEXAS GAS AND ELECTRIC LIGHT ASSOCIATION.

TERMS:
SUBSCRIPTION—Three Dollars per annum, in advance.
Single copies, 10 Cents.

AGENTS:
New York—American News Co., 39 and 41 Chambers St.
Germany—B. Westermann & Co., of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, JULY 13, 1896.

(*Continued from page* 54.)

have been lighted with mineral oil. Thus, in 1896, the oil light apparatus of the Isle of Groix and of the Isle of Sein (Bay of Biscay), and in 1897, that of Ailly (Channel), of Isle of Batz, and of d'Armen (Bay of Biscay), and of Camarat (Mediterranean) will be transformed to lighting flash lights and lighted with Auer-Welsbach burners. The result of the experiments and photometric measurements made with incandescent gas burners and mantles at the Central Depot in Paris, may be summed up as follows :

1. The luminous power of a Welsbach burner fed by rich gas compressed at 1.5 meter (4.92 ft.) of water is 300 candles; while the luminous power of a 10-wick Trinity House burner is 1,800 candles.

2. But in a first order 8-panel apparatus, with lower and upper catadioptric lenses, the Welsbach burner gives 185,000 candles, while the 10-wick Trinity House burner gives only 115,000 candles. The reason of this difference is to be sought in the much greater intrinsic luminous intensity or the Welsbach light, as well as in the greater diffusion of light in a given apparatus.

3. A 4-panel second order (700 millimeters) apparatus lighted with one Welsbach burner fed by compressed oil gas at a pressure of 1.5 meter of water gives flashes of 300,000-candle power, whilst an ordinary oil light of first and second order only gives flashes of 80,000 and 50,000 candles respectively. By increasing the pressure of the gas the intensity of beam could easily be increased ; but for ordinary purposes the pressure adopted is adequate. By using double optical apparatus in the same lantern, incandescent gas lighting flash lights of 600,000 candles can be obtained, the flashes being one-tenth of a second in duration at intervals of 5 seconds.

4. The great advantages of incandescent gas applied to lighting flash lights consist in the economy and greatly superior facility of attendance as compared with hyper-radiant apparatus, or biform, triform, and quadriform combinations. The comparative cost and the luminous power of a second order incandescent gas light and a hyper-radiant light—*e. g.*, that of Antifer, work out as follows :

	Second Order (700 Millimeters) 4-Panel Apparatus, Incandescent Gas.		Hyper-Radiant (1,300 Millimeters) Apparatus, Oil.	
Optical apparatus.....	30,000 f.	$6,000	94,000 f.	$18,800
Rotary mechanism, mercury bath, lamps, burners and mercury.....	18,000 f.	3,600	18,000 f.	3,600
	48,000 f.	$9,600	112,000 f.	$22,400
Luminous power.....	300,000 candles*		220,000 candles.	

*It is seen that this luminous power obtained with a single optical apparatus is about the same as that of the Tory Island triform hyper-radiant light of 326,000 candles.

Clay Pipe Sewers.

Mr. William Eccles, writing on this topic, says that in considering the adaptability of clay sewers for house-drainage, we have a question of the utmost importance ; the sewer being the channel through which is conveyed the refuse of the household and excrement substances, that if left standing would soon develop the germs of many diseases.

It is important that the drain should not allow any of this matter to escape and collect near the house to generate diseases. On this depends much of the health of the household and is of great importance, because leaks in such sewers are not always visible or evident, but often occur in obscure places, saturating the ground with putrid matter, dealing out diseases and death to people living near it, little less successfully than the open cesspools that are formed by clay-pipe sewers leaking day after day, under the houses in which we live. They are more dangerous because less obvious, as people guard against dangers they see. It is unknown dangers that are most destructive. Who that has seen the excavation of ground going on through which an old clay sewer has been laid, and noticed the color of the earth where it lay, and the effluvium that arises when the ground is moved, is not convinced that such a sewer beneath a dwelling is a constant menace to the health of its occupants ?

I do not propose to consider the possibility of finding material and sufficiently skilled labor to produce a sewer made of clay that will fill all of the demands made of such a sewer, but rather whether clay sewers, such as we find them made and laid, and in common use, are commendable for house drainage.

Pottery is one of the earliest evidences of the art of man we know of. We find it under such conditions that prove that it is capable of withstanding the natural causes of decoy, and that it is practically imperishable of itself. But as it must necessarily be made in short lengths, it must have joints capable of withstanding the disintegration caused by time, and the action of water and other matter that are brought in contact with it internally and externally, and the various conditions by which sewers are surrounded.

Joints of this kind are seldom if ever found, for the following reasons among others : The inaccuracy of clay pipes in size and shape (as they are often bent and warped in manufacturing them) requires that the hub end should be large to accommodate this irregularity, necessarily making the space large between the two pipes, which must be filled with cement and exposed to the powerful action of the sewage. The cement in common use will seldom be found equal to the demands made of it ; because it is generally chosen, not for its quality, but because it is the cement most easily procured, or cheapest. It is mixed with sand or mud, as may be most convenient, in varying degree, and is no more impervious to sewage than the ground it lays on. Better and very good joints are made being locked together by coarse threads filled with cement on joining together. But the difficulties in making changes are so great that they are impracticable. In laying clay pipes it is difficult to avoid disturbing the pipes before the cement is set and firm. If moved ever so little the cement joint is no longer concreted, and will leak, and the leak will soon increase in size. If the ground on which it lays be not very solid, it will sink with the weight of the water, or be washed away to lower levels, leaving the pipe unsupported, and, as it is inflexible and brittle, it easily breaks under such conditions.

Another cause is the unskilled and reckless manner in which clay pipes are laid, altered or repaired, such work being generally done by some one who is expert only with a pick or shovel, and not much impressed with the importance of the work he is doing. The use of a level seems to be an extravagant waste of time, for he thinks he is capable of adjusting the grade with his wonderful eye. And a curve is superfluity, as he is ever ready to level the sod of a straight pipe and make an angle as acute as the hub will allow, and if that is not acute enough, he will sacrifice half the hub to make it so ; that the diameter is reduced, or offsets made at the joint inside, on which solid matter may rest and accumulate, is unknown, or a matter of indifference to him. A liberal use of cement at some joint, he thinks, is good. and sometimes he neglects to remove the ridge of cement at some joint, caused by pushing the cement along in front of the small end of some pipe. If from these or other causes the sewer becomes choked, it is easy to cut one or more hand holes to clear the obstruction, and sometimes these holes are very carelessly patched, instead of removing them. After a repetition of this clearing process two or three times, we have a very dilapidated looking sewer, capable of admitting any amount of sewerage or sewer gas into the building. To this add the ease with which a tenant may get a hole cut and a waste pipe inserted for some vessel he may temporarily need, which on his removal, he takes with him, but the hole is left unclosed.

These are a few of the reasons why clay sewers are undesirable and even dangerous under buildings, and ought to be prohibited within the lot line, by the authorized conservators of the public.

The Market for Gas Securities.

Silver politics and unclean Democratic politicians have given the Wall Street traders golden opportunities to smash values, which the such-as is-before-me traders have employed to their best bent. The net result is a market largely oversold, and the ultimate result will be the earthing of many "shorts" before September is well marked on the calendar. The surprise of the week is the "wobbliness" of Equitable, which is offered at 200. Standard issues, and New York and East Rivers as well, are quoted at figures much below their respective values. Our advice to investors is to buy any city gas share that can be purchased at the ruling figures, no matter what the silver or gold politicians may try to do. Consolidated stands the racketting very well, and it is a gilt-edged investment at the reported market prices.

Brooklyn Union is reported at 89 to 91. It ought to be, on merit, 105 to 110. Chicago gas is another especially bright bargain at anything under 60. Our advice is to buy right through the general gas list, for investment only. We have never in these columns, or outside of them, advised the purchase of gas stocks for other than investment account.

Gas Stocks.

Quotations by Cochran & Close, Brokers and Dealers in Gas Stocks.

35 Wall St., New York City.

July 13.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$35,430,000	100	153	155
Central	500,000	50	150	..
" Scrip	220,000	..	100	.
Equitable	4,000,000	100	195	200
Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	114	.
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	225	235
" Bonds	1,500,000	1,000	100	102
Municipal Bonds	750,000	.	..	.
Northern	150.000	50	79	80½
" Bonds	150,000	1,000	..	98
New York and East River	5,000,000	100	34	36
Preferred	2,000,000	100	..	73
Bonds 1st 5's	3,500,000	1,000	100	101½
" 1st Con. 5's	1,500,000	..	89	90½
Richmond Co., S. I.	348,650	50	50	..
" Bonds	100,000	1,000	..	..
Standard	5,000,000	100	75	78
Preferred	5,000,000	100	104½	106½
Bonds, 1st Mortgage, 5's	1,500,000	1,000	110	112
Yonkers	299,650	50	180	..
Out-of-Town Companies.				
Brooklyn Union	15.000,000	100	89	91
" " Bonds (5's)	15,000,000	1,000	105½	106
Bay State	5,000,000	50	19½	20½
" Income Bonds	2,000,000	1,000	..	42
Boston United Gas Co.--				
1st Series S. F. Trust	7,000,000	1,000	84	85
2d " " "	3,000,000	1,000	66	70
Buffalo Mutual	750,000	100	125	..
" Bonds	200,000	1,000	95	100
Central, San Francisco	2,000,000	..	95	..
Chicago Gas Co.	25,000,000	100	56¾	57
Chicago Gas Lt. & Coke Co. Guaranteed Gold Bonds.	7,650,000	1,000	94	94¼
Columbus	1,069,000	..	..	65
1st Mortgage	1,085,000	..	..	96
Consumers. Jersey City	2,000,000	100	..	80
" Bonds	600,000	1,000	99	101
Cincinnati G. & C. Co.	7,000,000	100	198¾	200
Consumers, Toronto	1,600,000	50	184½	187
Capital, Sacramento	500,000	50	..	41
Bonds (6's)	150,000	1,000	..	..
Consolidated, Baltimore	1,000,000	100	61	62½
Mortgage, 6's	3,600,000	..	107	107½
Chesapeake, 1st 6's.	1,000,000	..	..	..
Equitable, 1st 6's.	910,000	..	..	..
Consolidated, 1st 5's	1,490,000	..	..	..
Detroit	4,000,000	..	32	33
" Con. Bonds	4,312,000	..	..	82
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Fort Wayne	2,000,000	..	85	90
" Bonds	2,000,000	..	90	95
Hartford	750,000	25	..	145
Indianapolis	2,000,000	..	132	136
" Bonds, 6's	2,650,000	..	103	105
Jersey City	750,000	20	180	..
Lafayette Gas Co., Ind	1,000,000	100	90	95
Bonds	1,000,000	1,000	92	95
Louisville	2,570,000	50	.	130
Laclede, St. Louis	7,500,000	100	20¾	21½
Preferred	2,500,000	100	..	82
Bonds	9,034,400	1,000	91½	93
Little Falls, N. Y.	50,000	100	..	100
Bonds	25,000	..	..	100
Montreal, Canada	2,000,000	100	200	.
Newark, N. J., Gas Co.	1,000,000	..	93	98
Bonds, 6's	4,000,000	..	123	..
New Haven	1,000,000	25	225	..
Oakland, Cal.	2,000,000	..	52	53¼
" Bonds	750,000	..	..	..
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	2,100,000	1,000	..	108
2d "	2,500,000	1,000	104	105
Peoples, Jersey City	500,000	50	..	175
Paterson, N. J.	.....	25	99	102
Rochester Gas & Elec. Co.	2,150,000	50	..	..
Preferred	2,150,000	50	88	..
Consolidated 5's	2,000,000		87½	90
San Francisco, Cal.	10.000,000	100	94½	95
St. Paul Gas Light Co.	1,500,000	100	67½	70
1st Mortgage, 6's	650,000	..	84	87
Extension, 6's	600,000	..	..	..
General Mortgage, 5's	2,400,000	.	88	90
Syracuse, N. Y.	500.000	25	..	..
Washington, D. C.	2,000,000	20	250	
Western, Milwaukee	4,000,000	100	62	65
Bonds, 5's	3,556,000	.	87	90
Wilmington, Del.	500,000	5	188	190

Advertisers' Index.

GAS ENGINEERS.

	Page
Jos. R. Thomas, New York City	77
Wm. Henry White, New York City	75
Fred. Bredel, Milwaukee, Wis.	58
H. C. Slaney, Brooklyn, N. Y.	75
Geo. R. Rowland, New York City	75
The Western Gas Construction Co., Fort Wayne, Ind.	66
Humphreys & Glasgow, New York City	62
T. G. Lansden, St. Louis, Mo.	75
American Gas Co., Phila., Pa.	58
David Leavitt Hough, New York City	77

CHEMISTS.

Herman Poole, New York City	57

PROCESSES.

Bartlett, Hayward & Co., Baltimore, Md.	78
United Gas Improvement Co., Phila., Pa.	65
Burdett Loomis, Hartford, Conn.	74
National Gas and Water Co., Chicago, Ills.	67
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	73
The Western Gas Construction Co., Fort Wayne, Ind.	66

GAS WORKS APPARATUS AND CONSTRUCTION.

James R. Floyd & Sons, New York City	76
Continental Iron Works, Brooklyn, N. Y.	74
Deily & Fowler, Phila., Pa.	76
Kerr Murray Mfg. Co., Fort Wayne, Ind.	72
Stacey Mfg. Co., Cincinnati, Ohio.	75
Bartlett, Hayward & Co., Baltimore, Md.	78
Davis and Farnum Mfg. Co., Waltham, Mass.	72
R. D. Wood & Co., Phila., Pa.	74
Isbell-Porter Company, New York City	74
Fred. Bredel, Milwaukee, Wis.	58
United Gas Improvement Co., Phila., Pa.	65
Berlin Iron Bridge Co., East Berlin, Conn.	62
National Gas and Water Co., Chicago, Ills.	67
Economical Gas Apparatus Construct'n Co., Toronto, Ont.	73
The Western Gas Construction Co., Fort Wayne, Ind.	66
Humphreys & Glasgow, New York City	62
Gas Engineering Co., Pittsburgh, Pa.	72
American Gas Co., Phila., Pa.	58

SCRUBBERS AND CONDENSERS.

G. Shepard Page's Sons, New York City	75
R. D. Wood & Co., Phila., Pa.	74
James R. Floyd & Sons, New York City	76
Continental Iron Works, Brooklyn, N. Y.	74
Gas Engineering Co., Pittsburgh, Pa.	72

REGENERATIVE FURNACES.

Bartlett, Hayward & Co., Baltimore, Md.	78
Fred. Bredel, Milwaukee, Wis.	58
J. H. Gautier & Co., Jersey City, N. J.	70
Parker-Russell Mining and Mfg. Co., St. Louis, Mo.	70
Adam Weber, New York City	70

TAR AND CARBONIC ACID EXTRACTOR.

G. Shepard Page's Sons, New York City	75

AMMONIA CONCENTRATORS.

Michigan Ammonia Works, Detroit, Mich.	57
G. Shepard Page's Sons, New York City	75
Gas Engineering Co., Pittsburgh, Pa.	72

GAS METERS.

John J. Griffin & Co., Phila., Pa.	80
American Meter Co., New York and Philadelphia.	79
The Goodwin Meter Co., Phila., Pa.	78
Helme & McIlhenny, Phila., Pa.	79
D. McDonald & Co., Albany, N.Y.	79
Nathaniel Tufts, Boston, Mass.	78
Maryland Meter and Mfg. Co. Baltimore, Md.	78
Metric Metal Co., Erie, Pa	78
Keystone Meter Co., Royersford, Pa.	60
Buhl Stamping Company, Detroit, Mich.	79

PREPAYMENT METERS.

American Meter Co.. New York and Philadelphia	79
John J. Griffin & Co., Phila., Pa	80
D. McDonald & Co., Albany, N. Y.	79

GAS AND WATER PIPES.

Ohio Pipe Co., Columbus, Ohio	77
M. J. Drummond, New York City	77
R. D. Wood & Co., Phila., Pa.	74
Warren Foundry and Machine Co., New York City	77
Donaldson Iron Co., Emaus, Pa.	77
Addyston Pipe and Steel Co., Cincinnati, O.	77

PIPE CUTTERS.

Wm. Anderson, East Boston, Mass.	60

STEAM BLOWER FOR BURNING BREEZE.

H. E. Parson, New York City	67

GAS COALS.

Penn Gas Coal Co., Phila., Pa.	69
Perkins & Co., New York City	68
Despard Gas Coal Co., Baltimore, Md.	69
Westmoreland Coal Co., Phila., Pa.	69
Berwind-White Coal Mining Co., New York and Phila.	68

CANNEL COALS.

Perkins & Co., New York City	68
Macfarlane & Co., Louisville, Ky.	57

GAS ENRICHERS.

Standard Oil Co., New York City	69
The Sun Oil Co., Pittsburgh, Pa.	69

COKE CRUSHER.

C. M. Keller, Columbus, Ind.	69

CONVEYING MACHINERY.

C. W. Hunt Company, N. Y. City.	57

GAS GAUGES.

The Bristol Co., Waterbury, Conn.	57

GAS GOVERNORS.

Connelly Iron Sponge and Governor Co., New York City	67
Isbell-Porter Co., New York City	74
The Wilder Mfg. Co. Phila., Pa.	57

SELF-SEALING MOUTHPIECE DOORS.

Isbell-Porter Company, New York City	74
Continental Iron Works, Brooklyn, N. Y.	74
G. Shepard Page's Sons, New York City	75

RETORTS AND FIREBRICK.

J. H. Gautier & Co., Jersey City. N. J.	70
B. Kreischer & Sons, New York City	70
Adam Weber, New York City	70
Laclede Firebrick Mfg. Co., St. Louis, Mo.	70
Cyrus Borgner, Phila., Pa	70
James Gardner, Jr., Pittsburgh, Pa.	70
Henry Maurer & Son, New York City	70
Baltimore Retort and Firebrick Co., Baltimore, Md.	70
Parker-Russell Mining and Mfg. Co., St. Louis, Mo.	70
Brooklyn Firebrick Works, Brooklyn, N. Y.	70

CEMENTS.

C. L. Gerould & Co., Mount Vernon, N. Y.	70

INCANDESCENT GAS LAMPS.

Welsbach Commercial Co., Phila., Pa.	59

MICA GOODS.

The Mica Mfg. Co., New York City	57

BURNERS.

C. A. Gefrorer, Phila., Pa.	74

LAVA GAS TIPS.

D. M. Steward Mfg. Co., Chattanooga, Tenn.	57

GAS TUBING.

Wm. M. Crane & Co., New York City	20

PURIFYING MATERIALS.

Connelly Iron Sponge and Governor Co., New York City	67
Greenpoint Chemical Works, Brooklyn, N. Y.	67
Henry W. Douglas, Ann Arbor, Mich.	67

EXHAUSTERS.

The P. H. & F. M. Roots Co., Connersville, Ind	64
Isbell-Porter Company, New York City	74
Connelly Iron Sponge and Governor Co., New York City	67

VALVES.

Ludlow Valve Manufacturing Co., Troy, N.Y.	66
Chapman Valve Manufacturing Co., Boston, Mass.	66
R. D. Wood & Co., Phila., Pa.	74
Continental Iron Works, Brooklyn, N. Y.	74
The P. H. & F. M. Roots Co., Connersville, Ind.	64
Isbell-Porter Co., New York City	74
The Western Gas Construction Co., Fort Wayne, Ind.	66

ELECTRICAL APPARATUS.

Wm. Henry White, New York City	75

GAS ENGINES.

Otto Gas Engine Works, Phila., Pa.	40
The American Gas Engine Co., Phila., Pa.	71
Backus Water Motor Co., Newark, N. J.	16

ENGINES AND BOILERS.

The Hazelton Boiler Company, New York City	60
W. G. & G. Greenfield, East Newark, N. J.	60

PURIFIER SCREENS.

John Cabot, New York City	60

GAS STOVES.

American Meter Co., New York and Philadelphia.	63
The Goodwin Meter Co., Phila., Pa.	78
George M. Clark & Co., Chicago, Ills.	61
Maryland Meter and Manufacturing Co., Baltimore, Md.	78
William M. Crane & Co., New York City	20
Keystone Meter Co., Royersford, Pa.	60
A. Weiskittel & Son, Baltimore, Md.	61

CHINA GAS KILNS.

William M. Crane & Co., New York City..... 20

GASHOLDER PAINT.

New York Marine Paint Co., Poughkeepsie, N.Y..... 66

GASHOLDER TANKS.

J. P. Whittier, Brooklyn, N. Y..... 66

GASHOLDERS.

Bartlett, Hayward & Co., Baltimore, Md..... 73
Continental Iron Works, Brooklyn, N. Y..... 74
Deily & Fowler, Philadelphia, Pa..... 76
Davis & Farnum Mfg. Co., Waltham, Mass..... 72
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 72
Stacey Mfg. Co., Cincinnati, Ohio. 75
R. D. Wood & Co., Philadelphia, Pa..... 74

BOOKS, ETC.

Scientific Books..... 76
Field's Analysis..... 68
Digest of Gas Cases..... 69
Directory of Gas Companies..... 77
Practical Photometry..... 70
Coal Tar Genealogical Tree..... 68
Management of Small Gas Works 62
Handbook on Gas Engines 77

DIVIDEND NOTICE.

OFFICE OF THE UNITED GAS IMPROVEMENT CO., DREXEL BUILDING, PHILA., June 25, 1896.

The Directors have declared a quarterly dividend of 2 per cent. ($1 per share), payable on July 15, 1896, to stockholders of record at the close of business July 1st. Checks will be mailed.

1099-3 EDWARD C. LEE, Treas.

Position Wanted

By a man 23 years of age

In a Coal or Water Gas Works.

Can read and set meters, lay mains, run services, set gas stoves, etc. Can furnish the best of references. Address

1100-4t "D.," care this Journal.

Position Desired

By a man 24 years of age, who thoroughly understands his business (coal or water gas), also office work in all its details. Is at present in charge of a works, but for good reasons wishes to make a change. Has had 10 years' experience, and is not afraid of work. A position preferred where good service would be appreciated; salary is a secondary consideration. Best of references. Address

1099-3 "ENGINEER," care this Journal.

Position Wanted

As Superintendent of Gas Works or Gas and Electric Light Works.

Has been in the employ of the Long Branch (N. J.) Lighting Company as Superintendent for the last 11 years, and is a practical mechanic, thoroughly understanding the laying out and erection of plant and the making of coal and water gas. Best of references. Address CHAS. J. LUTHER,

1100-2 Box 142, Long Branch, N. J.

FOR SALE,

Controlling Stock in Water, Gas and Electric Light Properties

in city of 10,000 inhabitants. Plants in first-class condition, and prosperous. Address

1100-2 "ILLINOIS," care this Journal.

FOR SALE,

One 8-ft. Station Meter, with 12-in. connectons. In good order. Can be delivered Aug. 1.

Two Horizontal Return Tubular Boilers. Size, 54 in. by 16 in.

One Condenser, 5 ft. diameter by 22 feet long, and contains 64 3-inch tubes. In good condition.

1096-tf NEW HAVEN (CONN.) GAS LT. CO.

For Sale.

A Small Gas and Electric Light Plant,

in a Southern city of 3,800 inhabitants.

Address FORT WAYNE ELECTRIC CORPORATION,

1097-tf Fort Wayne, Ind.

Special Prices on

BEAR CREEK CANNEL COAL

will be made during the dull summer months. It will pay you to get your Cannel housed in good weather and at the lowest price. Find out about it.

MACFARLANE & CO.,

1095-tf Louisville, Ky.

Utilize Your Gas Liquor.

NO EXTRA LABOR OR OPERATING EXPENSES.

Ammonia Concentrator,

Not Expensive. Write to

STROH & OSIUS, Pat'ees, or Mich. Ammonia Works, Detroit, Mich.

Patent Lava Gas Tips.

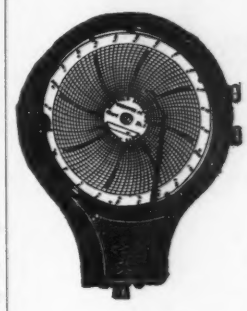
UNIFORMITY GUARANTEED.

ALL SIZES AND SHAPES.

D. M. STEWARD MFG. CO.,

CHATTANOOGA, TENN.

BRISTOL'S RECORDING PRESSURE GAUGE



For Continuous Records of

Street Gas Pressure.

Simple in Construction,
Accurate in Operation,
Low in Price,
Fully Guaranteed.

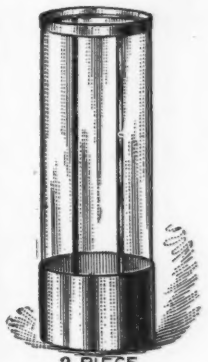
Send for Circulars.

THE BRISTOL CO.

Waterbury, Conn.

Received Medal at World's Columbian Exposition.

Our Mica Chimneys



2 PIECE MICA CHIMNEY.

Etched Chimneys to Order.

For Welsbach Lights

ARE THE

BEST IN THE WORLD.

Get Catalog and Discounts.

The MICA MFG. CO.

Micasmiths,

88 Fulton Street, N. Y. City.

HERMAN POOLE ✻ Chemical Engineer,

323 West 34th Street, N. Y. City,

Makes a Specialty of

PURIFICATION

And the Utilization of Waste Products in Gas Manufacture

C. W. HUNT COMPANY.

THE HUNT TIP CAR.

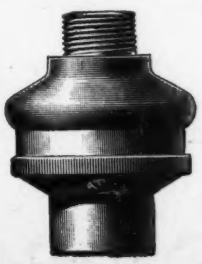
COKE CARS for Gas Works,
TIP CARS for Carrying Ashes,
CHARGING CARS for Bringing Coal from the Storage Bins to Boiler Room and Retort Houses.

INDUSTRIAL RAILWAYS

Specially designed for handling material in and around

Gas Works, Coal Yards, Factories, Etc., Etc.

45 BROADWAY, - - NEW YORK.



THE GREATEST IMPROVEMENT IN GAS LIGHTING

Has been made by

WILDER'S VOLUMETRIC GOVERNORS.

They control the pressure at the burner, and deliver the quantity for which they are set regardless of high or low pressure in the supply.

WELSBACH LIGHTS are fully controlled, and the governors soon pay for themselves by preventing the breaking of mantles and chimneys. Thousands are already in use. Orders may be given to the Welsbach Co., or sent to ourselves.

THE WILDER MANFG. CO., - 816-822 Cherry St., PHILADELPHIA.

FRED. BREDEL, C.E.

Coal and Water Gas Plants,

OWN SYSTEM.

Recuperative Furnaces, Washers, Condensers, Purifiers, Purifying Machines.

Gas Enriching Plants to Enrich Coal Gas up to 24 Candle Power, and Making a White, Bright, Non-smoking Gas.

COMPLETE GAS WORKS, COKE CONVEYERS, ETC.

No. 118 Farwell Avenue, · · Milwaukee, Wis.

AMERICAN GAS COMPANY,

222 South Third Street, Philadelphia, Pa.

Owns, Operates, Buys and Leases Gas Works.

ALSO UNDERTAKES ALL KINDS OF CONSTRUCTION WORK.

Especially the Installation or Extension of Plants for the Manufacture of Gas from Caking Coal.

The attention of Gas Managers is particularly called to the many improvements in this method of manufacture instituted during the past fifteen years, and the extremely low cost at present of Coal Gas.

CORRESPONDENCE RESPECTFULLY SOLICITED. Address

GEO. G. RAMSDELL, Gen'l Mangr.

THE

New and Improved Welsbach Light.

No. 34 Light, with No. 10 and No. 43 Opal Shade.

CAUTION!

BEWARE of counterfeit lights which are being offered in genuine Welsbach boxes. See that each box bears our trade mark, "WELSBACH," and that the seals are unbroken before you accept it.

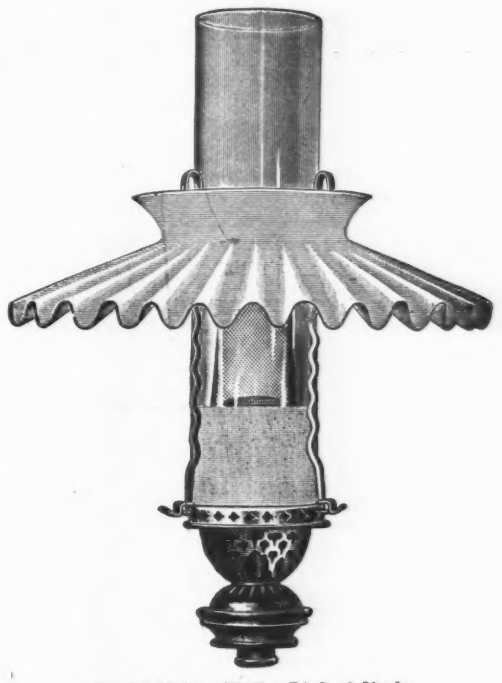
CAUTION!!

Persons dealing in counterfeit lights are liable to criminal prosecution, and a large number of indictments have already been found against such dealers.

All infringements of this Company's patents will be promptly and vigorously prosecuted, dealers and users being equally liable. This Company will prosecute all parties in whose possession infringing lights are found.

This notice is given in view of an effort now being made to introduce into this country infringing lights made in Germany, the sale of which, there, has been prohibited by the recent decision of the German Patent Office sustaining the validity of the Welsbach patents.

For your own protection, see that you get the genuine Welsbach light, as both the counterfeit and the infringing lights are greatly inferior.



No. 34 Light, with No. 74 Opal Shade.

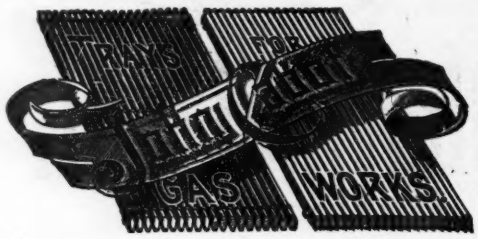
Welsbach Commercial Co.,

DREXEL BUILDING, PHILADELPHIA.

Special Trays for Iron Sponge or Oxide of Iron.

CHURCH'S TRAYS a Specialty.

Reversible, Strongest, Most Durable, Most Easily Repaired



306-310 Eleventh Avenue, New York.

We also make the Cheapest and Strongest
REVERSIBLE BOLTED TRAYS IN THE MARKET.
Send for Circulars.

A CONVENIENT
BINDER for the JOURNAL

STRONG.
DURABLE.
LIGHT.
SIMPLE
CHEAP.
HANDSOME
Price, $1.

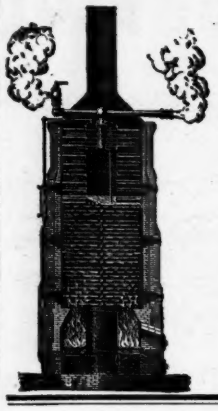
A.M. Callende & Co.,
32 Pine st.,
N. Y. City

THE ANDERSON Patent Cutter Carrying Link
Made in all sizes.

Will cut from 2 in. to 24 in.
Pipe Cutting Tool

For Cutting Cast, Wrought Iron, Gas & Water Pipes.
WM. ANDERSON,
425 Meridian Street,
East Boston, Mass.. or
WALDO BROS.,
88 Water Street, Boston, Mass.

The Pioneer Vertical Water-Tube Boiler of the World!



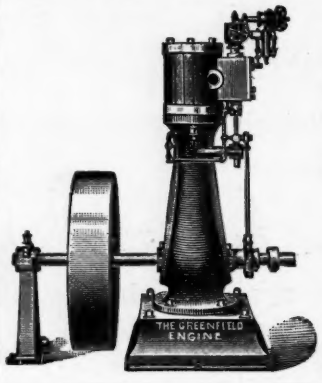
THE HAZELTON OR PORCUPINE BOILER.

After Sixteen Years of Active Service in all the Principal Industries, this Boiler has Proven Itself Superior to all Others in Economy of Fuel, Durability, Safety and General Efficiency.

NO EXPLOSIONS OR ACCIDENTS OF ANY KIND.

Correspondence Solicited.

The HAZELTON BOILER COMPANY,
Sole Proprietors and Manufacturers,
Cable Address, "Paila," New York.
Tele., "1229-18th St.," New York.
Gen'l Office, 716 E. 13th St., N.Y., U.S.A.



GREENFIELD
Steam Engine Works.
Established 1874.
MANUFACTURERS OF
Greenfield Stationary, Portable and Yacht
ENGINES AND BOILERS.
Also Horizontal, Automatic and Variable Cut-off Engines.
Sizes from 3 to 75 Horse Power.
Also Vertical and Horizontal and Marine Boilers.
Steam Pumps and Adams' Grate Bars.
W. G. & G. GREENFIELD, - · EAST NEWARK, N. J.

Midsummer Extension

MAKES MANY MORE METERS

NECESSARY. NOW is the time to buy, or NEVER. Hesitate NO LONGER.

KEYSTONE METERS meet every requirement. They never fail. Registry accurate. Fittings carefully adjusted. Diaphragms well seasoned, gas-tight, flexible, lasting. Cases of heaviest Tin Plate. Workmanship of a superior grade. Attach your mains to Keystone Meters for good results. Prompt delivery, all sizes.

THE KEYSTONE METER CO., Royersford, Pa.

THE BARTLETT LAMP MFG. CO.,
66 W. Broadway, N. Y. City,
Agts. for New York, New Jersey & Conn.

CAHILL, SWIFT & CO.,
121-207 S. 7th St., St. Louis, Mo.,
Western Agents.

WIESTER & CO.,
17 & 19 New Montgomery St., S. Francisco,
Pacific Agents.

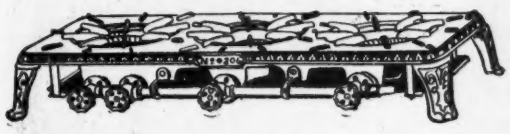
JEWEL GAS STOVES

A few of the world's best Gas Stoves. All prominent demonstrators of cooking use them. Nine-tenths of the Chicago apartment houses are furnished with the same . . . . . .

One Name
Covers All.

52 Styles of Cookers.

54 Styles of Heaters.



A JEWEL CATALOG
IS WORTH THE ASKING.

GEORGE M. CLARK & COMPANY, Makers, CHICAGO.

Eastern Agency, 284 and 286 Pearl Street, N. Y. City.

FIRE KING GAS STOVES

BEST IN THE WORLD.

Fire King Gas Stoves and Ranges are of the highest grade and have every modern improvement. We are always wide awake and determined to keep our goods ahead of all others.

Ranges from $12.00 to $72.00, List.
Stoves from 25 Cents to $9.00, List.

We have the most complete Gas Stove Factory in the World.

Send for Catalogue and Discount.

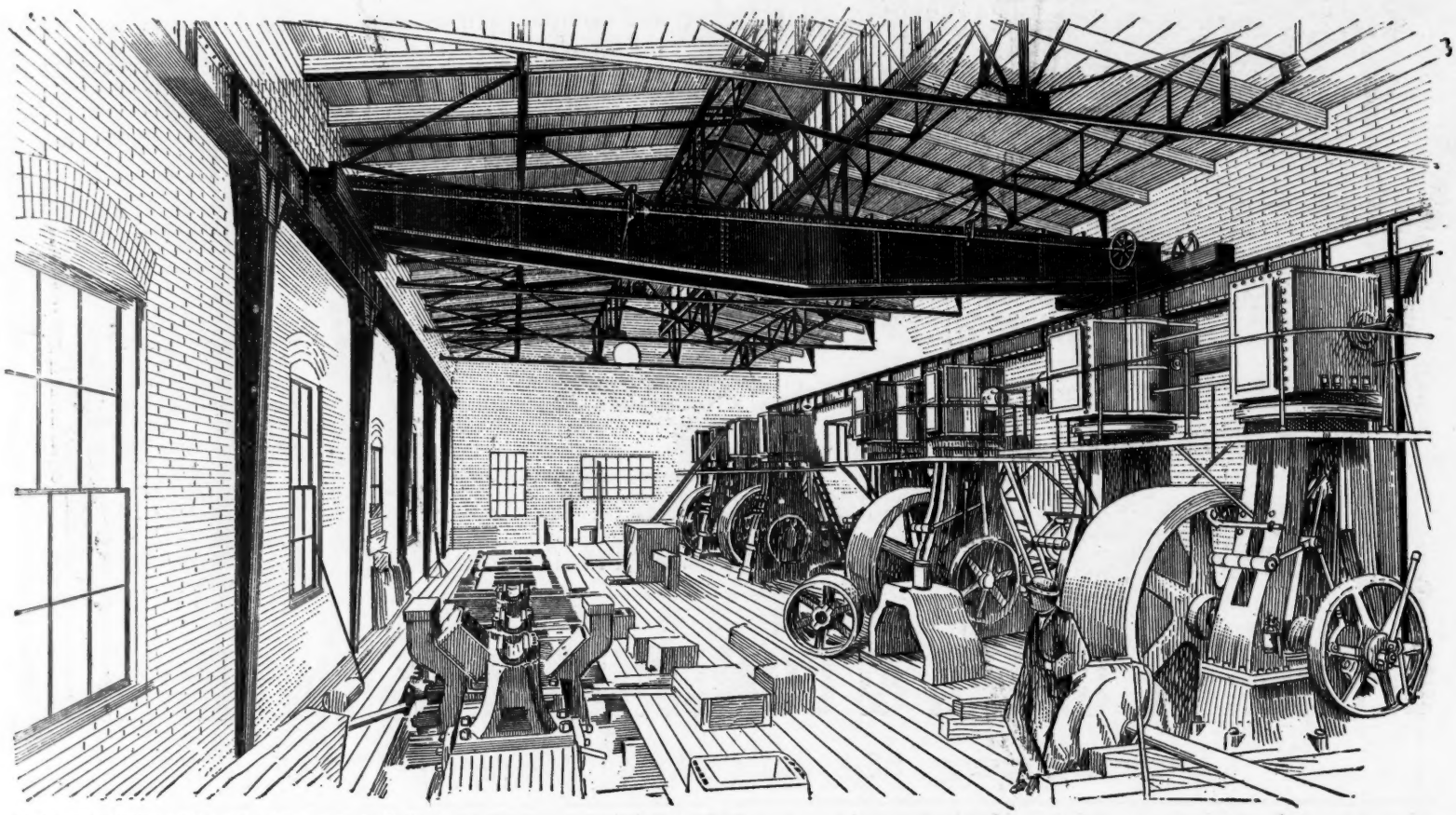
New York Branch, - 1387 Broadway.
New England Depot, Waldo Brothers, Boston, Mass.

A. WEISKITTEL & SON, - Baltimore Md.

CHAS. M. JARVIS, Prest. & Chief Engineer. BURR K. FIELD, Vice-President. GEO. H. SAGE, Secretary. FRANK L. WILCOX, Treasurer.

THE BERLIN IRON BRIDGE CO.

Engineers, Architects, and Builders of Iron and Steel Structures.



The above illustration is taken direct from a photograph, and shows the interior of a Power House designed and built by us for the Worcester Traction Company, at Worcester, Mass. The building is 47 feet wide and 120 feet long, with a traveling crane as shown. The roof being very flat, it is covered with plank and tar and gravel. The entire frame work is of steel, a light brick wall being placed between the posts to protect the interior of the building from the weather.

Write for Illustrated Catalogue.

Office and Works, No. 6 Railroad Avenue, East Berlin, Conn.

ALEX. C. HUMPHREYS, M.E.,
MANHATTAN LIFE BUILDING,
(64 BROADWAY,)
NEW YORK.

CABLE ADDRESS,
LONDON & NEW YORK,
"HUMGLAS."

ARTHUR G. GLASGOW, M.E.,
9 VICTORIA ST.,
LONDON, S. W.,
ENGLAND.

HUMPHREYS & GLASGOW,

CONTRACTING AND CONSULTING

GAS ENGINEERS.

WATER GAS PLANT A SPECIALTY.
GAS PROPERTIES EXAMINED AND VALUED.
ADVICE AS TO IMPROVEMENT OF GAS PROPERTIES AND MANAGEMENT.

THE MANAGEMENT OF SMALL GAS WORKS.

By C. J. R. HUMPHREYS.

Price $1.

A. M. CALLENDER & CO., No. 32 Pine Street New York.

(Copyrighted, 1894, by the AMERICAN METER CO.

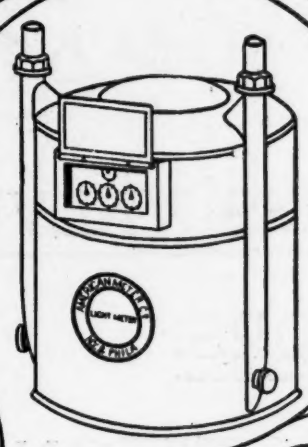
AMERICAN METER CO.

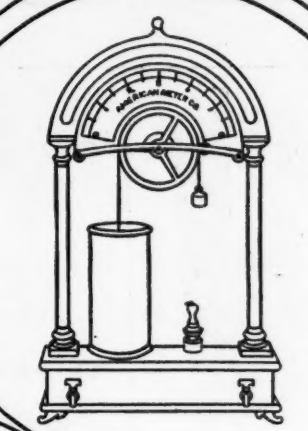
ESTABLISHED 1834. INCORPORATED 1863.

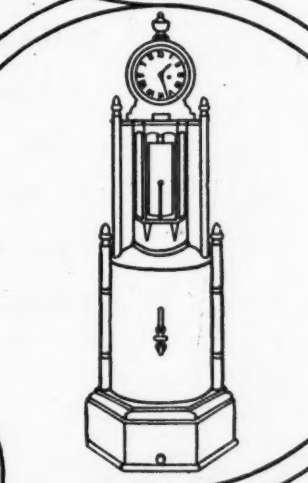
NEW YORK AND PHILADELPHIA,

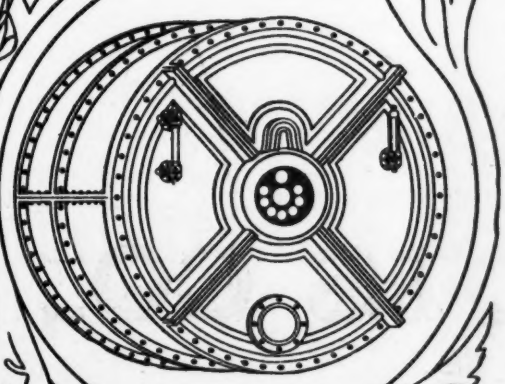
CHICAGO, ST. LOUIS,

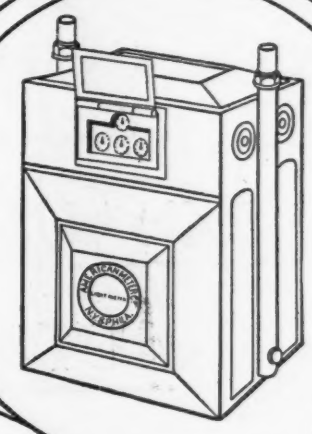
SAN FRANCISCO.

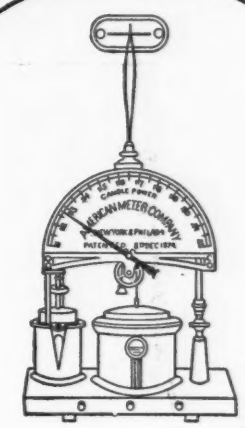


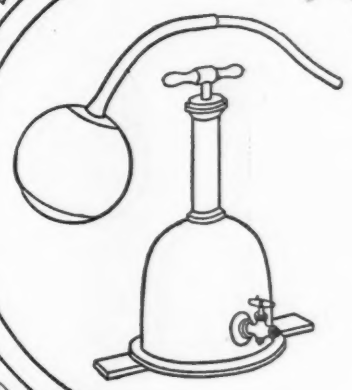


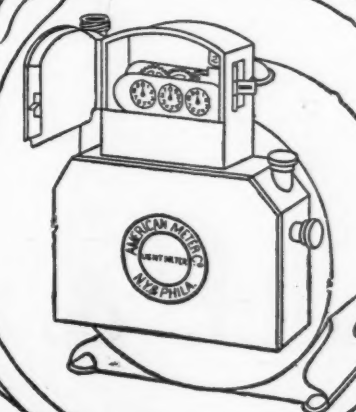












PUBLIC LIGHTING TABLE.

JULY, 1896.

Day of Week.	Table No. 1. Following the Moon. Date.	Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Wed.	1	8.00 PM	12.00 AM	7.30	3.15
Thu.	2	8.00 LQ	12.30	7.30	3.15
Fri.	3	8 00	12.50	7.30	3.15
Sat.	4	8.00	1.10	7.30	3.15
Sun.	5	8.00	1.40	7.30	3.15
Mon.	6	8.00	2.20	7.30	3.15
Tue.	7	8.00	3.40	7.30	3.15
Wed.	8	8.00	3.40	7.30	3.15
Thu.	9	8.00	3.40	7.30	3.15
Fri.	10	8.00 NM	3.40	7.30	3.15
Sat.	11	8.00	3.40	7.30	3.15
Sun.	12	8.00	3.40	7.30	3.15
Mon.	13	8.00	3.40	7.30	3.15
Tue.	14	8.00	3.40	7.30	3.15
Wed.	15	9.10	3.40	7.30	3.15
Thu.	16	9.40	3.40	7.20	3.15
Fri.	17	10.10 FQ	3.40	7.20	3.15
Sat.	18	10.40	3.40	7.20	3.15
Sun.	19	11.20	3.50	7.20	3.15
Mon.	20	12.10 AM	3.50	7.20	3.15
Tue.	21	1.10	3.50	7.20	3.15
Wed.	22	2.20	3.50	7.20	3.15
Thu.	23	No L.	No L.	7.20	3.15
Fri.	24	No L. FM	No L.	7.20	3.15
Sat.	25	No L.	No L.	7.20	3.15
Sun.	26	7.50 PM	9.30 PM	7.20	3.15
Mon.	27	7.50	9.50	7.20	3.15
Tue.	28	7.50	10.10	7.20	3.15
Wed.	29	7.50	10.30	7.20	3.15
Thu.	30	7.50	10.50	7.10	3.30
Fri.	31	7.50	11.10	7.10	3.30

TOTAL HOURS LIGHTING DURING 1896.

By Table No. 1.	Hrs.Min.	By Table No. 2.	Hrs.Min.
January	220.40	January	423.20
February	207.00	February	367.40
March	193.00	March	355.35
April	174.10	April	298.50
May	164.00	May	264.50
June	142.10	June	234.25
July	142.10	July	243.45
August	150.50	August	280.25
September	163.00	September	321.15
October	193.10	October	374.30
November	207.00	November	401.40
December	237.30	December	433.45
Total, yr.	2194.40	Total, yr.	4000.00

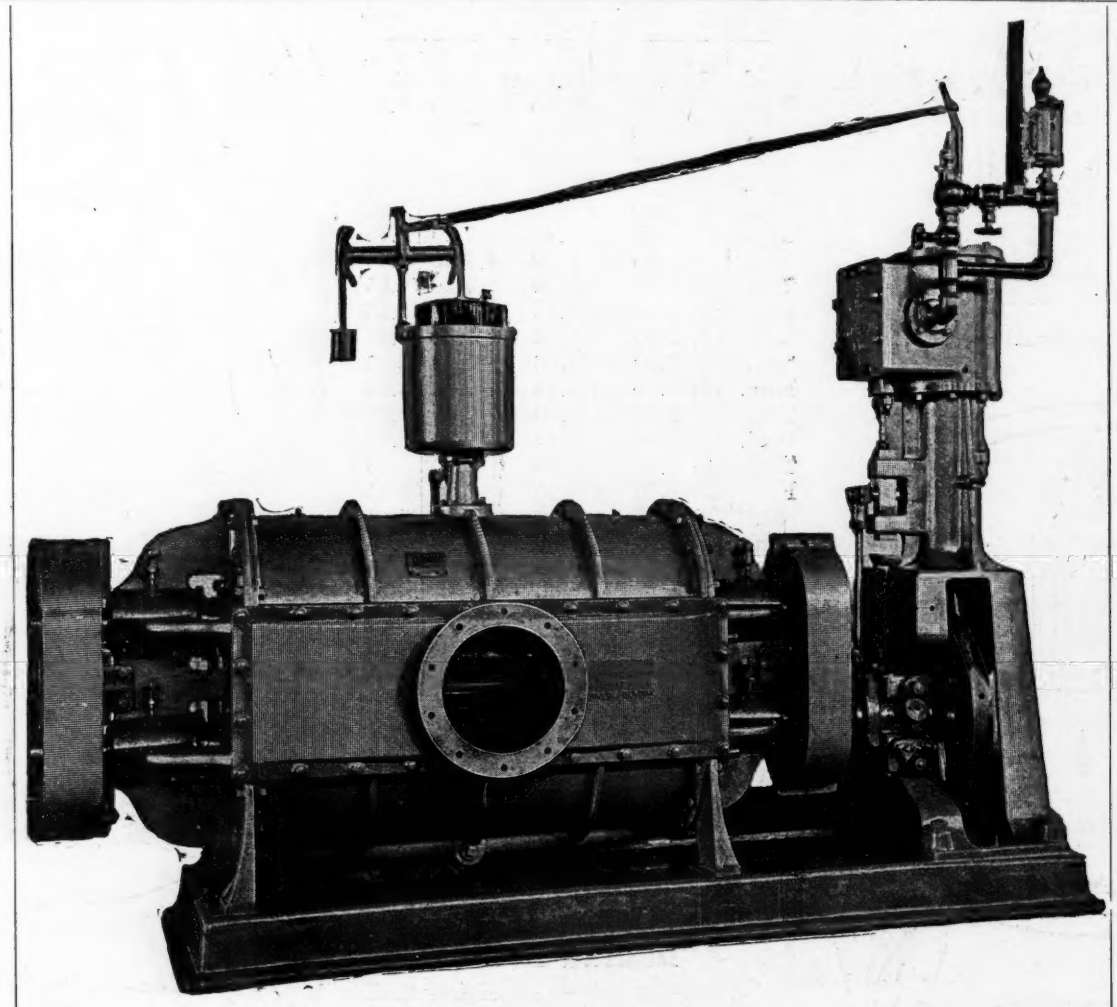
P. H. & F. M. ROOTS CO.,

Connersville, Ind.

GAS EXHAUSTERS. BYE-PASS VALVES.

AUTOMATIC GAS GOVERNORS.

GAS VALVES. PIPE FITTINGS.



New Design of Direct Connected Engine and Exhauster on Same Bedplate.

This Design is Used for all Exhausters from No. 7 to No. 10, Inclusive.

Write for Illustrated Catalogue.
Estimates submitted on application.

P. H. & F. M. ROOTS CO.,

Connersville, Indiana.

New York Office, 109 Liberty Street, J. B. STEWART, Manager.

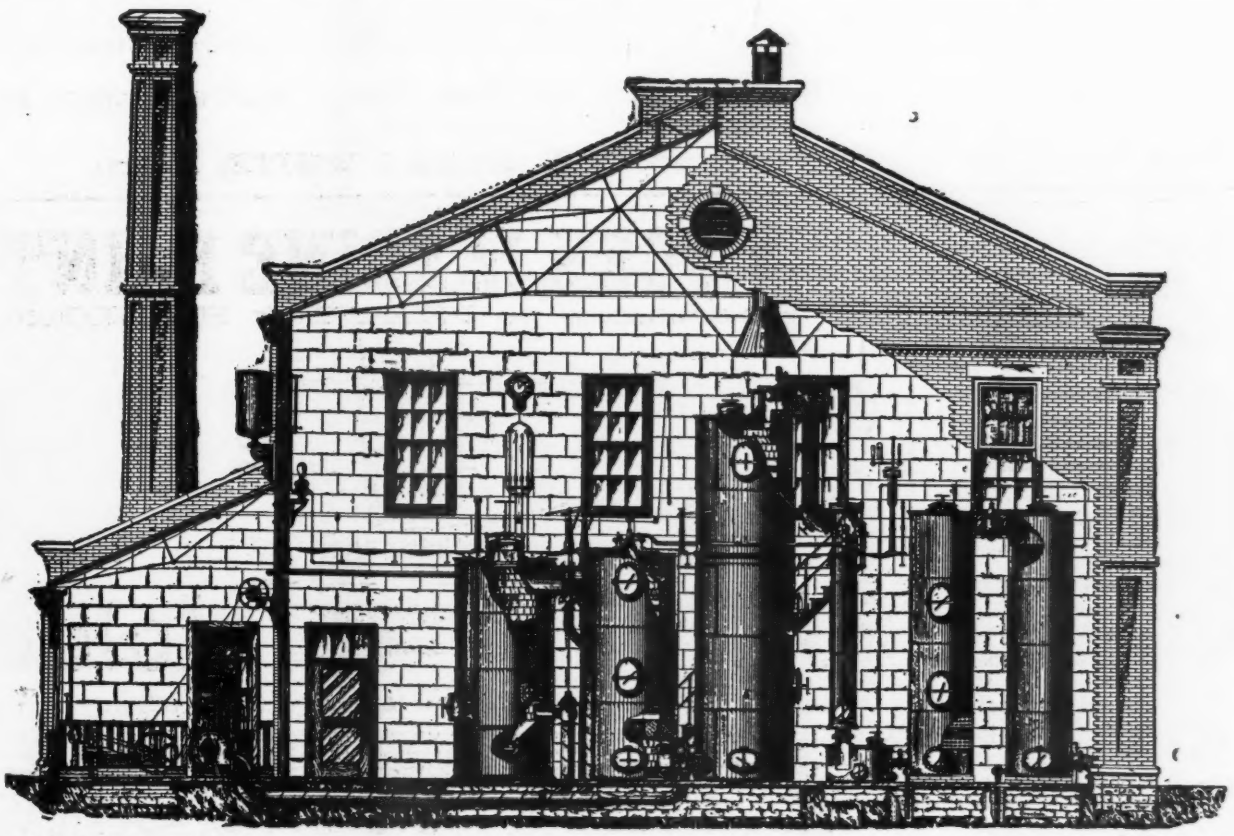
THE UNITED GAS IMPROVEMENT CO.,

DREXEL BUILDING, PHILA., PA.

Inquiries from any part of the United States should be addressed to the Philadelphia Office.

BUILDERS OF

THE STANDARD LOWE WATER GAS APPARATUS.



Standard "Double Superheater" Lowe Apparatus, designed for the use of Naphtha, Crude Oil, or "Distillates."

BUILDERS, LESSEES AND PURCHASERS OF GAS WORKS.

Water Gas Plants, either independent or auxiliary to Coal Gas Works, erected to meet any conditions. Apparatus designed to use any grade of Oil. and Anthracite Coai, or Gas House or Oven Coke.

PAMPHLETS, PLANS AND ESTIMATES FURNISHED UPON APPLICATION.

THE WESTERN GAS CONSTRUCTION CO.,

ENGINEERS and BUILDERS,

FORT WAYNE, INDIANA.

Water Gas Apparatus . . .

Improved Double Superheater Settings,
Improved Single Superheater Settings,
Special Designs for Small Works.

Our apparatus is designed to use any grades of Oils or Naphthas, Gas House or Oven Coke, or Anthracite Coal. Results are Guaranteed.

Coal Gas Apparatus . . .

Agents and Builders { **For FRED. BREDEL—Washers and Purifying System, Mouthpieces and Bench Castings.**
For GEO. SHEPARD PAGE'S SONS—Walker Ammonia Concentrators and Sulphate Stills, Walker Patent Mouthpieces.

Manufacturers of THE WESTERN GAS VALVE, all Iron, Double Gate, 4 to 36 Inch.

Purifiers, Condensers, Scrubbers, Street Main Specials, Iron Roofs, Iron Floors, Oxide Elevators and Conveyer Machinery.

New York Office, 32 Pine Street, WM. HENRY WHITE, Engr.

THE

LUDLOW VALVE MFG. CO.,

MANUFACTURERS OF

VALVES,

Double and Single Gate, ½ in. to 72 in., outside and inside Screws. Indicator, etc., for Gas, Water, Steam, Oil and Ammonia.

SEND FOR CIRCULAR.

SEND FOR CIRCULAR.

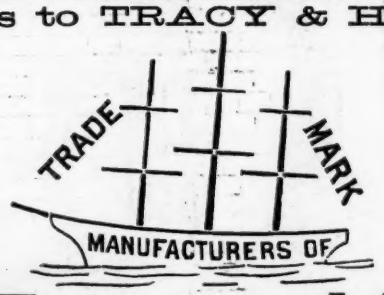
ALSO.

Hydraulic Main Dip Regulators, Check Valves, Foot Valves, Yard Wash and Fire Hydrants.

OFFICE AND WORKS:
938 to 954 River St. & 67 to 83 Vail Av.
TROY N Y.

NEW YORK MARINE PAINT CO.

Successors to TRACY & HADDEN.



PAINT PECULIARLY ADAPTED TO STAND ON Holders

And all Ironwork about Gas Works.

POUGHKEEPSIE, N. Y.

CHAPMAN VALVE MANUFACTURING CO.,

MANUFACTURERS OF

Valves and Gates for Gas, Ammonia, Water, Etc.

Also, Gate Fire Hydrants with and witnout Independen Nozzle Valve. All Work Guaranteed.

Works & Gen'l Office, Indian Orchard, Mass, Treasurer's Office, 72 Kilby & 112 Milk Sts., Boston Mass
Chicago Office, 24 West Lake St. New York Office, 28 Platt St.
St. Louis Office, L. M. Rumsey Mfg. Co., 810 North Second St

GASHOLDER TANKS AND GAS WORKS MASONRY COMPLETE

Plans prepared and Estimates furnished at short notice.

J. P. WHITTIER,

70 Rush St., Near Division Ave., **Brooklyn, N. Y.**

The Gas Engineer's Laboratory Handbook.

By JOHN HORNBY, F.I.C.

Price, $2.50.

A. M. CALLENDER & CO., 32 Pine Street N. Y. City

NATIONAL GAS AND WATER CO.,

218 La Salle Street, Chicago.

Builder and Operator of Gas Works.

The Rew Soft Coal Carbureted Water Gas Apparatus.

TESTED BY THREE YEARS' PRACTICAL OPERATION, AND FULLY GUARANTEED.

Plans and Estimates Upon Application.

IRWIN REW, President and Treasurer. E. E. MORRELL, Engineer.

CONNELLY IRON SPONGE AND GOVERNOR CO.,

(Successors to CONNELLY & CO.)

MANUFACTURERS OF GAS WORKS SPECIALTIES.

"IRON SPONGE." Saves money, saves labor, and is the most efficient purifying material ever offered as a substitute for lime. We guarantee a large saving, both in cost of material and labor.

AUTOMATIC GOVERNOR.

OVER FOUR HUNDRED NOW IN USE! NO WORKS COMPLETE WITHOUT IT!
WILL PAY FOR ITSELF WITHIN A YEAR! ITS SERVICE SECURES PERFECT DISTRIBUTION!
REDUCES LEAKAGE TO MINIMUM, and BENEFITS THE COMPANY and CONSUMER ALIKE!
IT IS THE ONLY RECOGNIZED AUTOMATIC GOVERNOR IN THE WORLD!

STEAM JET EXHAUSTER. Designed particularly for small works. Combines Exhaust Tube, Steam Governor, Gas Compensator and Bye-Pass Valves in the most compact form possible. Occupies but little space; uses very little steam; saves formation of carbon in retorts; increases yield 10 to 15 per cent. No works too small to use them profitably.

Prices given on all our specialties, delivered at any point in the United States. Correspondence solicited.

CONNELLY IRON SPONGE AND GOVERNOR CO., No. 365 Canal St., New York.

Practical Photometry.

A GUIDE TO THE STUDY OF THE MEASUREMENT OF LIGHT.

By William Joseph Dibdin.

Price, $3.00.

A. M. CALLENDER & CO.,

32 Pine Street, N. Y. City.

BOOKS.

DISTILLATION OF COAL TAR AND AMMONIACAL LIQUOR.

By GEORGE LUNGE. Price $12.50.

TREATISE ON THE COMPARATIVE COMMERCIAL VALUES OF GAS COALS AND CANNELS.

By DAVID A. GRAHAM. 8vo., Cloth. Price $3.

Orders for these books may be sent to this office.

A. M. CALLENDER & CO.,
32 PINE ST., N. Y. CITY

DOUGLAS' FERRIC OXIDE

For Gas Purification

Is a superior natural Hydrated Oxide of Iron. Will give a higher purification per bushel than any other material. We ship the pure Oxide of Iron, containing no sawdust, thus effecting a saving in freight, leaving the consumer to furnish the diluent at a nominal cost. It is now used by the largest gas companies in the West.

Full information, with references to many users, and prices delivered in any locality, furnished on application to

H.W. Douglas (Supt. Ann Arbor Gas Company) **Ann Arbor, Mich.**

IRON MASS

For Gas Purification.

Acts immediately, and more efficiently than any other purifying agent now in use.

Greenpoint Chemical Works.

JOHN SCHRIEVER, Manager.

Greenpoint Ave. & Newtown Creek, Brooklyn N.Y.

Parson's Steam Blower,

FOR IMPROVING BAD DRAUGHT IN BOILERS, AND FOR BURNING BREEZE OR OTHER WASTE MATERIAL.

PARSON'S TAR BURNER.

FOR UTILIZING COAL TAR AS FUEL.

PARSON'S AIR JET TUBE CLEANER,

FOR CLEANING BOILER TUBES.

These devices are all first-class. They will be sent to any responsible party *for trial*. No sale unless satisfactory. Manufactured by the WATERTOWN STEAM BLOWER COMPANY

H. E. PARSON, Supt., 621 Broadway, N. Y.

JAMES D. PERKINS. **PERKINS & CO.,** F. SEAVERNS.

228 and 229 Produce Exchange, New York City.

TIDEWATER SALES AGENTS FOR THE FOLLOWING:

Ocean Mine Youghiogheny Gas Coal,

Clinch Valley, Thacker & Logan Gas Coals

Old Kentucky Shale and O. K. Boghead.

Shipments from New York, Philadelphia, Baltimore and Norfolk.

BERWIND-WHITE COAL MINING COMPANY'S

Ocean Westmoreland Gas Coal.

Offices:

Washington Building, New York.

Betz Building, Philadelphia.

STRICTLY High Grade. . . . .
Carefully prepared.
For Gas Making or
Heavy Steaming.

FIELD'S ANALYSIS

For the Year 1895.

An Analysis of the Accounts of the Principal Gas Undertakings in England, Scotland, and Ireland. Being the Twenty-fourth Year of Publication. Compiled and Arranged by

JOHN W. FIELD Accountant to the Gas Lt. and Coke Co., London.

Price, $5. For Sale by

A. M. CALLENDER & CO., - No. 32 Pine Street, N. Y. City.

Coal Tar Genealogical Tree

MR. T. VINER CLARKE, of London, Eng., having compiled a novel Chart or Map illustrating the various

CHEMICAL PRODUCTS DERIVED FROM COAL AND COAL TAR,

In the form of a Genealogical Tree, including all the products discovered to date (the total number amounting to near 700), offers for sale a limited number of copies in Colors, mounted on Linen, with Rollers. Price, $3.50. Orders may be sent to

A. M. CALLENDER & CO., - - No. 32 Pine Street, New York.

GAS ENRICHERS. GAS COALS. GAS COALS.

The Despard Gas Coal Co.,

MINERS AND SHIPPERS OF

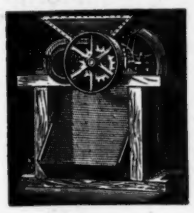
DESPARD GAS COAL,

AND MANUFACTURERS OF

COKE.

MINES, - - Clarksburgh, Harrison Co., West Va.
WHARVES, - - - Locust Point, Baltimore, Md.
OFFICE, - - - 44 South Street, Baltimore, Md.

ROUSSEL & HICKS, 71 Broadway, N. Y. } *AGENTS.* { BANGS & HORTON 60 Congress St., Boston.



KELLER ADJUSTABLE COKE CRUSHER.

Strong, Simple, Durable. Will Crush any Size Desired.

C. M. KELLER,
Sec. & Supt. Gas Lt. & Coke Co.,
Columbus, Ind.
Correspondence Solicited.

The Gas Engineer's Laboratory Handbook.

BY JOHN HORNBY, F.I.C. Price, $2.50.

A. M. CALLENDER & CO., 32 PINE ST., N. Y. CITY

GREENOUGH'S "DIGEST OF GAS CASES."

Price, $5.00.

This is a valuable and important work, a copy of which should be in the possession of every gas company in the country, whether large or small. As a book of reference it will be found invaluable. It is the only work of the kind which has ever been published in this country, and is most complete. Handsomely bound. Orders may be sent to

A. M. CALLENDER & CO., 32 Pine St., N. Y.

— THE —

PENN GAS COAL CO.

OFFER THEIR

Coal, Carefully Screened and Prepared for Gas Purposes.

Their property is located in the Youghiogheny Coal Basin, near Irwin and Penn Stations on the Pennsylvania Railroad, and on the Youghiogheny River.

Principal Office:

Room 720, Reading Terminal Building, Phila., Pa.

Points of Shipment:

Pennsylvania Railroad Piers; Greenwich Wharves, Delaware River; Pier No. 1 (Lower Side), South Amboy, N. J.

EDMUND H. MCCULLOUGH, Prest. CHAS. F. GODSHALL, Treas. H. C. ADAMS, Sec.

THE WESTMORELAND COAL CO.

Chartered 1854.

Mines situated on the Pennsylvania and the Baltimore and Ohio Railroads, in Westmoreland County, Pa.

POINTS OF SHIPMENT:

PHILADELPHIA, BALTIMORE, SOUTH AMBOY, N. J.,
WATKINS (SENECA LAKE), N. Y.

Since the commencement of operations by this Company its well-known Coal has been largely used by the Gas Companies of New England and the Middle States, and its character is established as having no superior in gas giving qualities, and in freedom from sulphur and other impurities.

Principal Office, 224 South 3d St, Phila., Pa.

THE SUN OIL CO.,

OHIO CRUDE OIL,

38 to 41 Degrees Gravity.

Toledo, O., and Pittsburgh, Pa.

Standard Oil Company,

GAS NAPTHA DEPARTMENT.

GAS NAPTHA.

GAS OIL.

Correspondence Solicited.

26 Broadway, New York City

RETORTS AND FIRE BRICK. RETORTS AND FIRE BRICK. RETORTS AND FIRE BRICK.

Established 1858. Incorporated 1890.
CHAS. E. GREGORY, Prest. DAVID R. DALY, V.-Prest. & Treas.
H. D. ABERNETHY, Sec.

J. H. Gautier & Co.
Greene & Essex Streets,
Jersey City, N. J.

MANUFACTURERS OF
CLAY GAS RETORTS, FIRE CLAY TILES,
FIRE BRICK and FIRE CLAY SPECIALTIES.

Ground Fire Clay, Fire Sand and Ground Fire Brick in Barrels and Bulk.

SOLE MANUFACTURERS OF THE
FLEMMING GENERATOR GAS FURNACE

Brooklyn Fire Brick Works,
MANUFACTURERS OF
CLAY RETORTS, FIRE BRICK,
Gas House and other Tile.
Office, 88 Van Dyke St., Brooklyn, N. Y.

LACLEDE FIRE BRICK MFG. CO.,
MANUFACTURERS OF
Fire Brick, Gas Retorts,
AND
ST. LOUIS STANDARD SEWER PIPE.
Blast Furnace and Cupola Linings, every description of Fire Clay Material, Fire Clay Flue Linings, Chimney Tops Dry Milled and Crude Fire Clays, etc.
OFFICE AND DEPOT
901, 903, and 905 Pine Street
ST. LOUIS, MO.

ESTABLISHED IN 1845.
B. KREISCHER & SONS,
OFFICE FOOT OF HOUSTON ST., E.R., N.Y.
Gas Retorts,
TILES, FIRE BRICK.
AND EVERYTHING IN THE FIRE CLAY LINE.

ADAM WEBER,
Proprietor,
Manhattan Fire Brick and Enameled Clay Retort Works
Works, Weber, N. J.
Office, 633 East 15th St., New York.

Modern Recuperative Furnaces
AND
Standard Fire Brick and Gas Retorts.

Works,
LOCKPORT STATION, PA.

—ESTABLISHED 1864.—
JAMES GARDNER, JR.,
Successor to WILLIAM GARDNER & SON.

Conestoga Bldg., Wood & Water Sts.
PITTSBURGH, PA. P. O. Box 373.

Fire Clay Goods for Gas Works.

SOLE REPRESENTATIVE OF THE McILHENNY REGENERATIVE BENCHES FOR THE U. S.

HENRY MAURER & SON,
(ESTABLISHED 1856.)
EXCELSIOR FIRE BRICK & CLAY
RETORT WORKS
WORKS, Perth Amboy, N. J.
OFFICE, 418 to 422 East 23d St., N. Y
Clay Gas Retorts,
BENCH SETTINGS,
Fire Brick, Tiles, Etc.

GEROULD'S IMPROVED RETORT CEMENT.
A Cement of great value for patching retorts, putting on mouthpieces, making up all bench-work joints, lining blast furnaces and cupolas. This cement is mixed ready for use. Economic and thorough in its work. Fully warranted to stick.
PRICE LIST.
In Casks, 400 to 800 pounds, at 5 cents per pound.
In Kegs, 100 to 200 " " 6 " "
In Kegs less than 100 " " 7 " "
C. L. GEROULD & CO.,
N. 3d & Prospect Avs., Mt. Vernon, N.Y.
Western Agent, H. T. GEROULD, Centralia, Ills.

Parker-Russell Mining and Mfg. Co.,
CITY OFFICE,
417 Pine Street, St. Louis, Mo.
PROPRIETORS OF THE
OAKHILL GAS RETORT & FIRE BRICK W'KS
Our immense establishment is now employed almost entirely in the manufacture of
Materials for Gas Companies
We have studied and perfected three important points. Our retorts are made to stand changes of temperature, the strongest heats of the furnace, and the abrasion of feeding and emptying. We construct
Half and Full Depth Benches of Our Own Design,
Containing 6, 8 or 9 Retorts.
We have Greatly Improved our Recuperators. Coal or Coke can be used as Fuel in Furnaces.

THEO. J. SMITH, Prest. J. A. TAYLOR, Sec'y.
A. LAMBLA, Vice-Prest. and Supt.
BALTIMORE RETORT & FIRE BRICK CO.
MANUFACTORY AT
LOCUST POINT BALTIMORE MD.
Clay Retorts, Blocks & Tiles
FIRE BRICK, FIRE CLAY,
AND FIRE CEMENT.
Red and Buff Ornamental Tiles and Chimney Tops. Baker Oven Tiles 12x12x2 and 16x16x2.
WALDO BROS., 88 WATER ST., BOSTON, MASS
Sole Agents for New England States.

PRACTICAL PHOTOMETRY.
A Guide to the Study of the Measurement of Light.
By WILLIAM JOSEPH DIBDIN.
With Numerous Illustrations Price, $3.00. A. M. CALLENDER & CO., 32 Pine Street, N. Y. City

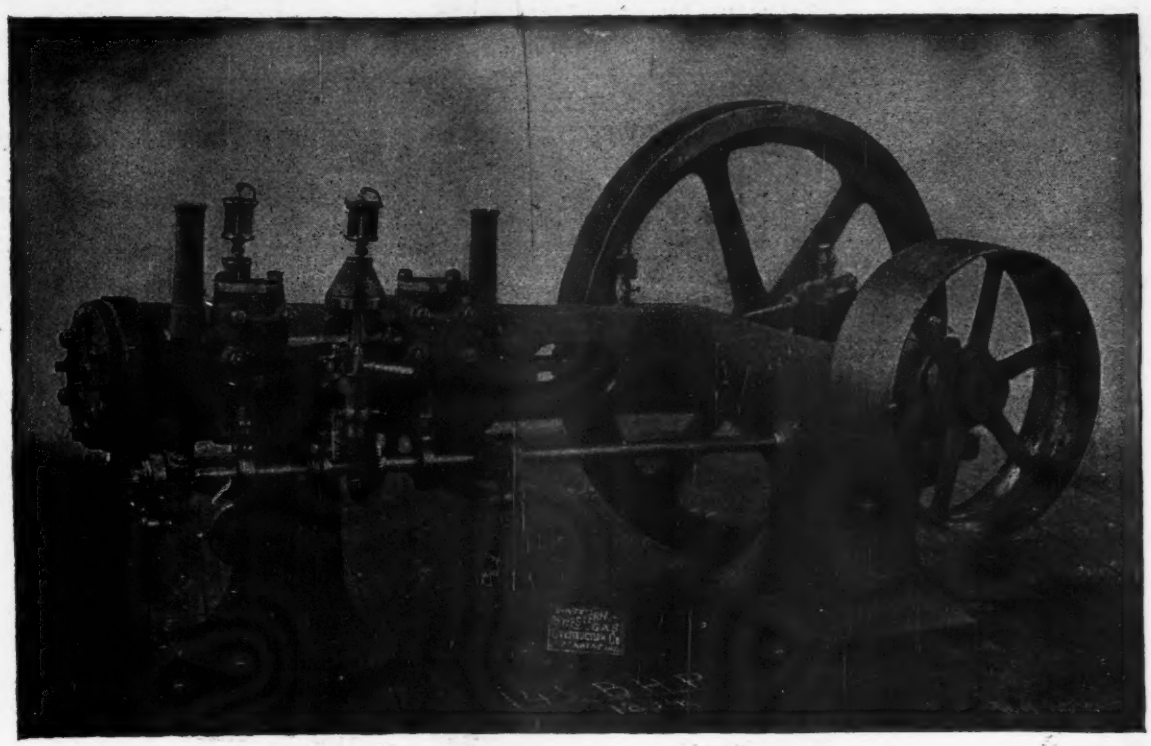
WM. W. GOODWIN, Prest. O. N. GULDLIN, V.-Prest. & Treas. H. B. GOODWIN, Sec. ERNEST F. LLOYD, Asst. Sec

THE AMERICAN GAS ENGINE CO.,

MANUFACTURERS OF

The Double-Acting Gas Engine,

Under the Patents of Griffin, and Dick, Kerr & Co., of London and Kilmarnock.



Single Cylinder.

Impulse Every Revolution.

(Two Strokes.)

15 to 500 Horse Power.

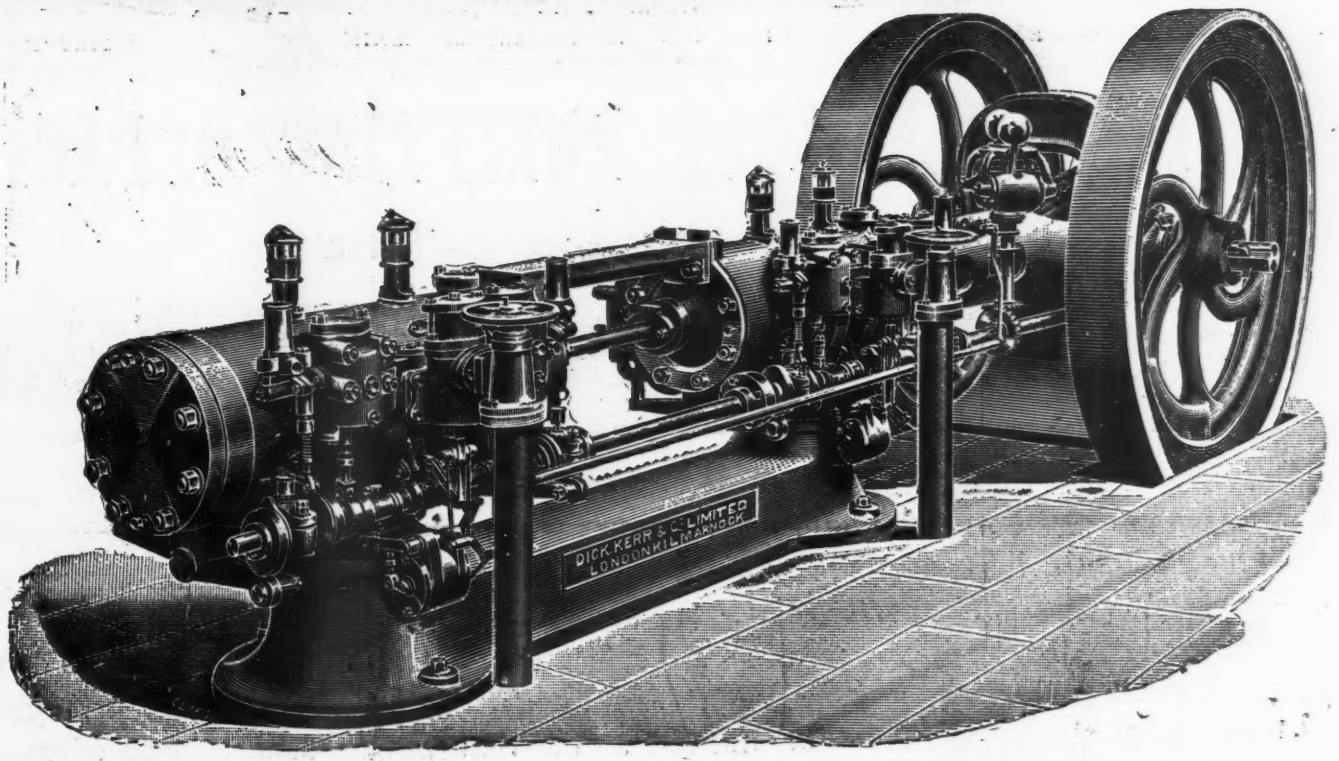
For General Work and Isolated Electric Plants.

Tandem Cylinder.

Impulse Every Stroke.

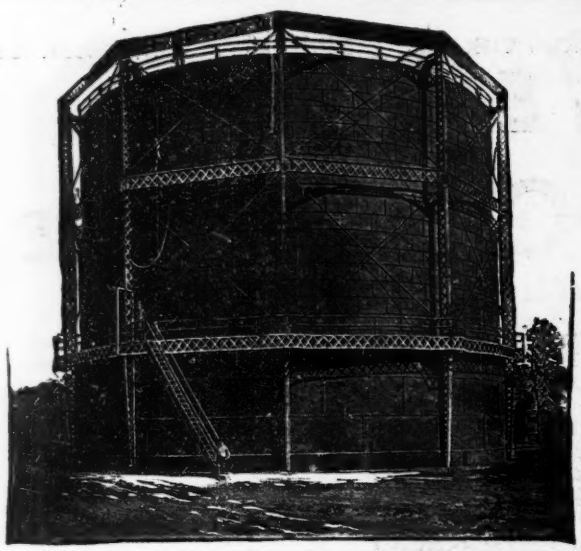
100 to 1,000 Horse Power.

For Central Stations and all work requiring extreme steadiness.



ESSENTIAL PRINCIPLE.—An impulse at each end of piston; using half force to each impulse; doubling the steadiness; reducing the wear on moving parts, and weight for given power. **CONSTRUCTION.**—The piston rod works through stuffing box in front end of cylinder, and connecting rod is carried in a cross-head working in a slide in frame, as in ordinary steam engine practice. All valves are of the poppet type, operated by cams on a single cam-shaft, giving positive movement to every working part. Tube or electric ignition. **RESULT.**—An engine of extreme simplicity and steadiness of action, the even wear on the cylinder and all working parts assuring increased economy, long life, and minimum cost in repairs. **RECORD.**—Successful and constant use in Great Britain for the past eight years. Address

W. W. GOODWIN, President, 532 Bourse Building, Philadelphia Pa., or
THE WESTERN GAS CONSTRUCTION CO. Bldrs. & Gen. Agts. Fort Wayne Ind.



DAVIS & FARNUM MFG. CO.,

WALTHAM, MASS.

Principal Office & Works, Waltham, Mass. Boston Office, R'm 18, Vulcan Bldg., 8 Oliver St.

Single, Double and Triple-Lift Gasholders of any Capacity. Tubular, Pipe and Sinuous Friction Condensers of all Sizes.

Steel Tanks for Gasholders, Iron Roof Frames and Floors, Purifying Boxes, Center Seal or Valve Connections, Bench Work, Reversible Lime Trays.

Self-Sealing and Pressed Steel Mouthpiece Lids.

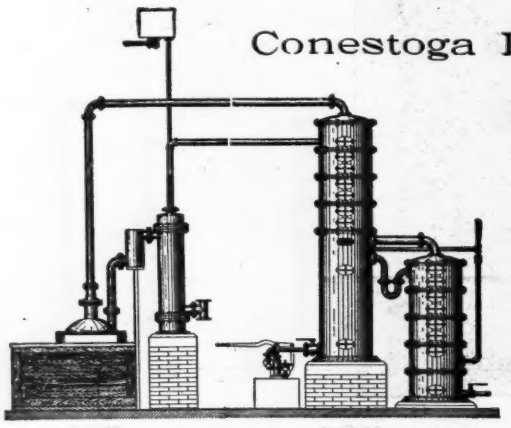
Coke Borrows, Coal Wagons, and all Apparatus Requisite for a Complete Gas Works.

Also, Gas and Water Pipe, Flanged Pipe, Sugar House Work, and Special Castings of all Descriptions.

GAS ENGINEERING COMPANY,

INCORPORATED,

Conestoga Building, PITTSBURGH, PA.



AMMONIA MACHINE.

MANUFACTURERS OF

Gas Works Machinery of all kinds,

PATENTEE AND OWNER OF

PITTSBURGH WASHER-SCRUBBER,

SOLE AGENT FOR

FELDMANN AMMONIA MACHINE,

For producing Sulphate, Aqua, Chloride and Concentrated Liquors.

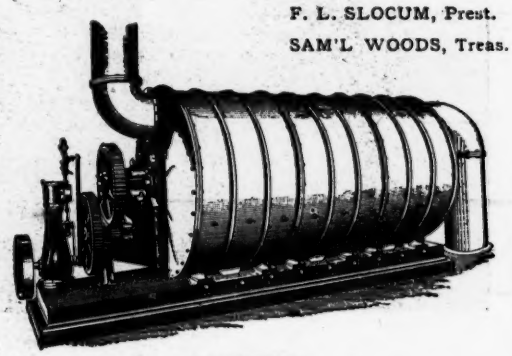
The Erection of Bi-Product Coke Ovens a Specialty.

Faux System of Recuperative Benches,

JAS. GARDNER, JR.
SOLE CONSTRUCTOR AND BUILDER.

NEW SYSTEM HYDRAULIC MAIN.

F. L. SLOCUM, Prest.
SAM'L WOODS, Treas.



SCRUBBER.

INCREASE YOUR PURIFYING CAPACITY

BY THE USE OF THE

"Crighton" Four-Box Center Seal Cap.

Having recently perfected and patented a Five-way Center Seal Cap, we are now in position to offer and recommend it to Gas Companies for increasing their purifying capacity at a moderate cost.

With this Cap you can have **all your Purifying Boxes in constant use,** and where four boxes are in operation at one time, **the capacity is increased one-third.**

Your present Center Seal can be used, and will **only require a new Cap.** Under ordinary circumstances **the change can be made in one day,** and will not necessitate the disturbing of your connections.

Now is the time to make the change, as the work can be done to good advantage during the season of your lightest output.

For information and prices address

KERR MURRAY MFG. CO.,

Manufacturers of Gas Works Apparatus and Holders,

FORT WAYNE, IND.

BARTLETT, HAYWARD & CO.

BALTIMORE, MD.

Triple, Double & Single-Lift

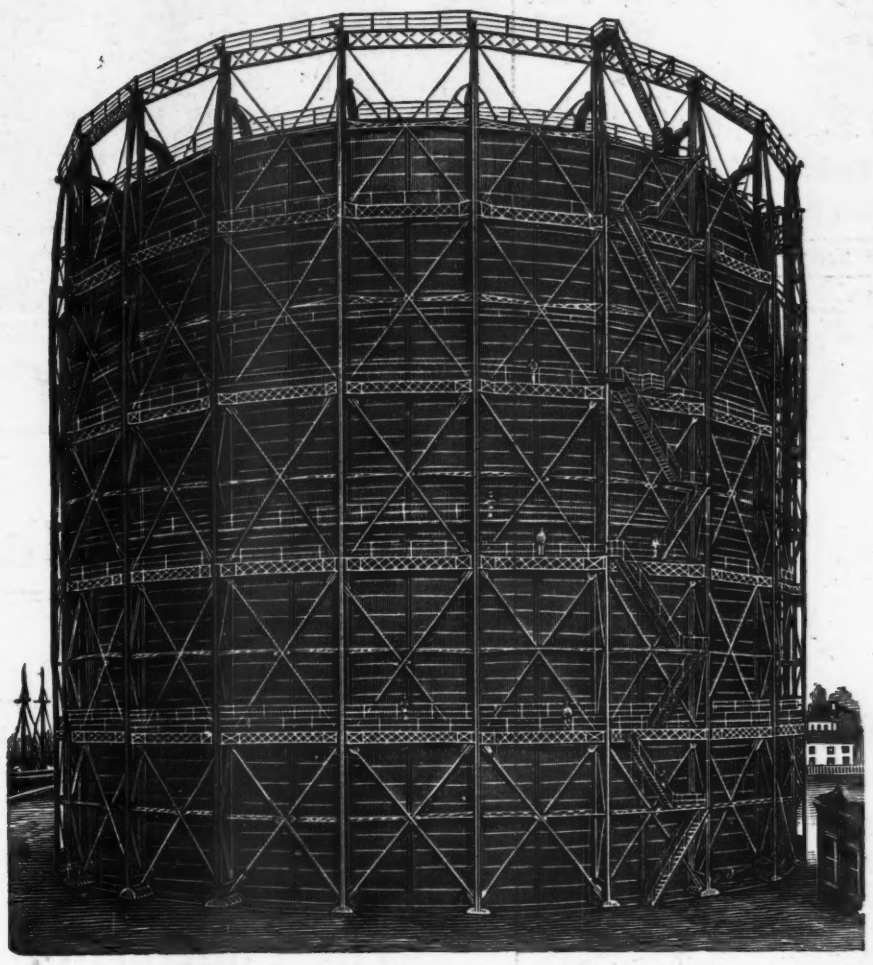
GASHOLDERS.

Iron Holder Tanks.

ROOF FRAMES.

Girders.

BEAMS



PURIFIERS.

CONDENSERS.

Scrubbers.

Bench Castings.

OIL STORAGE TANKS.

Boilers.

Three Four-Lift Gasholders, each of 4,289,500 Cubic Feet Capacity, Erected in Chicago.

The Wilkinson Water Gas Process.

THIRTY-CANDLE, NON-CONDENSABLE, FIXED GAS. THE MOST SUCCESSFUL GAS PROCESS IN OPERATION.

MILL'S REVERSIBLE LIME TRAYS.

Gas Works Designed and Constructed.

W. H. PEARSON, President. J. T. WESTCOTT, Gen'l Mang'r & Treas. L. L. MERRIFIELD, Chief Engineer.

The Economical Gas Apparatus Construction Co., Ld.

269 Front Street, East, - - Toronto, Canada.

ENGINEERS AND BUILDERS

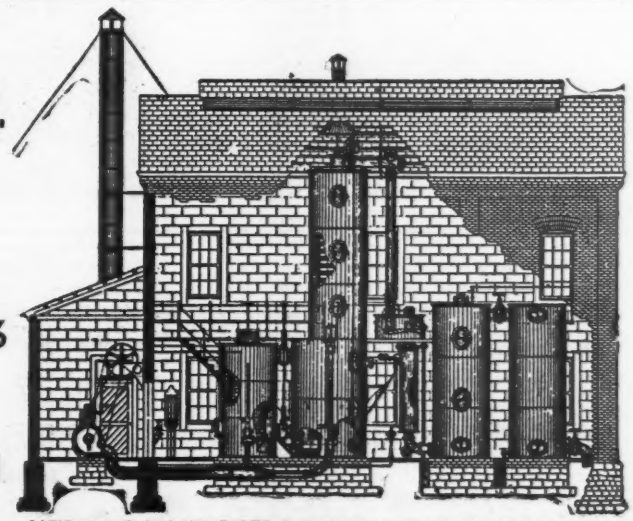
OF THE

Improved Lowe Water Gas Apparatus

Designed to give the Greatest Efficiency when using any kind of Oil, Anthracite Coal, Gas House or Oven Coke.

New Gas Works Built, Present Gas Plants, either Coal or Water, Remodeled

Catalogues, Plans and Estimates Furnished upon Application.



LOWE WATER GAS APPARATUS, MERRIFIELD-WESTCOTT-PEARSON SETTING.

R. D. WOOD & CO.,

ENGINEERS, IRON FOUNDERS, MACHINISTS.

400 Chestnut Street, Philadelphia, Pa.

MANUFACTURERS OF

CAST IRON PIPE.

BUILDERS OF

Gas Holders,

Single, Double and Triple Lifts, with or without Wrought Iron or Steel Tanks.

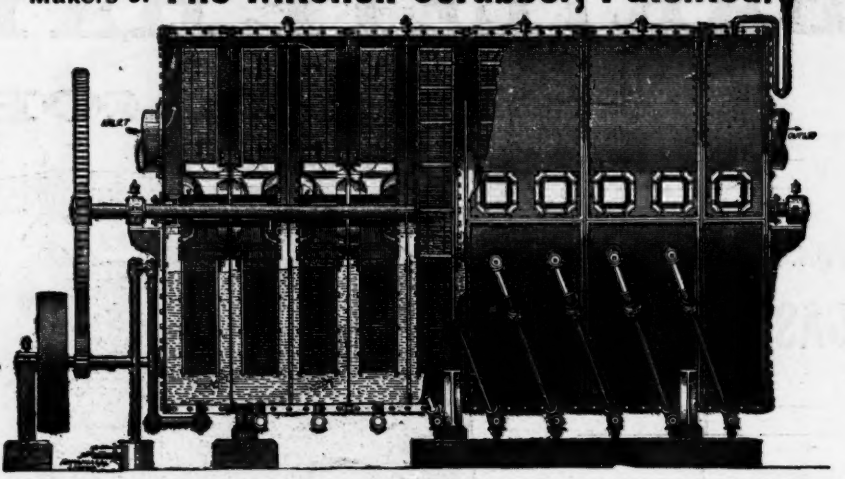
PURIFIERS, CONDENSERS, SCRUBBERS.

The Hopper Automatic Gas Governor

Send for Pamphlet.

Dunham Patent Specials.

Sole Makers of **The Mitchell Scrubber, Patented.**



ISBELL-PORTER CO.,

ENGINEERS AND CONTRACTORS FOR THE

Construction and Extension of Gas Works.

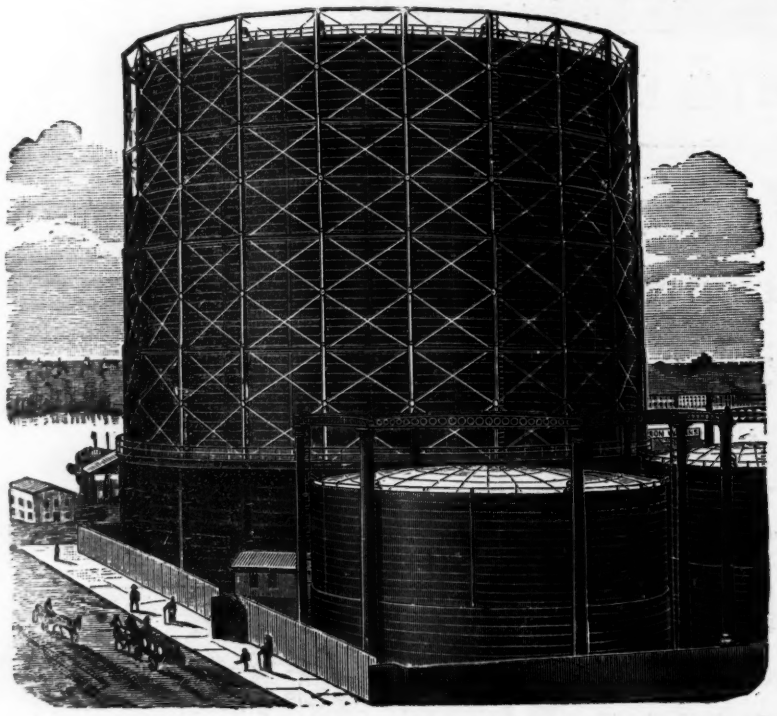
FOUNDERS AND MACHINISTS.

MANUFACTURERS OF

All Ironwork and Machinery Required in a Gas Plant.

Estimates, Drawings and Specifications furnished for the Alteration, Improvement, or Extension of Existing Works or the Construction of New Works.

245 Broadway, New York City. OFFICES **Bridge & Ogden Sts., Newark, N. J.**



The Continental Iron Works,

THOMAS F. ROWLAND, President.
WARREN E. HILL and CHAS. H. CORBETT, Vice-Presidents.
THOMAS F. ROWLAND, Jr., Secretary & Treasurer.

BROOKLYN, N. Y.

TAKE EAST TENTH OR TWENTY-THIRD STREET FERRIES FROM N. Y. TO GREENPOINT.

BUILDERS OF

Gas Holders.

Single and Multiple Section Gas Holders a Specialty.

Wrought Iron Gas Holder Tanks.

BENCH CASTINGS, RETORT LIDS.

Hydraulic Mains, Condensers, Scrubbers
Purifiers, Valves, Etc.

Self-Sealing Retort Mouthpieces & Lids

For Round, Oval, or "D" Retorts.

ILLUMINATING GAS! FUEL GAS!

THE LOOMIS PROCESS.

Now in successful operation at Works of John Russell Cutlery Co., Turner's Falls, Mass., and Henry Disston's Son's Saw Works, Tacony, Pa.

The Cheapest Gas Generating System in the World.

Plans and Estimates Furnished.

BURDETT LOOMIS, - - Hartford, Conn.

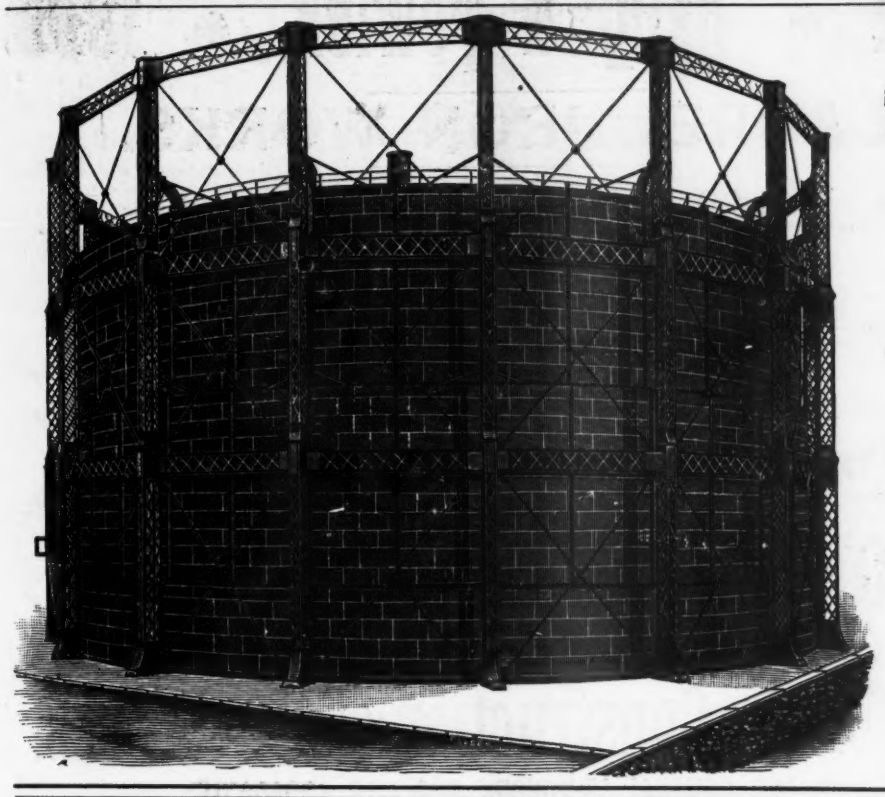
To Gas Companies.

We make to order **CAP BURNERS** to burn any amount under a stated pressure. Send for samples.

Also, SERVICE CLEANERS, DRIP PUMPS, and STREET MAIN PROVING APPARATUS.

C. A. GEFRORER,
948 N. 8th St., Phila., Pa.

GAS WORKS APPARATUS AND CONSTRUCTION. GAS WORKS APPARATUS AND CONSTRUCTION.



H. RANSHAW, Prest. & Mangr. T. H. BIRCH, Asst. Mangr
WILLIAM STACEY, Vice-Prest. R. J. TARVIN, Sec. & Treas.

THE STACEY MANUFACTURING CO
Established 1851.

Single, Double and Triple-Lift

GASHOLDERS,

Of any Capacity, with or without Wrought Iron or Steel Tanks.

Hydraulic Mains, Condensers, Scrubbers, Purifiers, Valves, etc.

Coal Gas Benches, Roof Frames,

OIL STORAGE TANKS.

Pressed Steel Mouthpiece Lids, Self-Sealing Mouthpiece Lids.

Cincinnati, Ohio.

George Shepard Page's Sons,

Sole Agents for

The "Standard" Washer-Scrubber,

The Walker Tar and Carbonic Acid Extractor, The Walker Sulphate and Ammonia Still,
The Walker Self-Sealing Pressed Steel Mouthpiece Lids.

The Berlin Center Valve. And Contractors for Ammoniacal Liquor.

No. 69 Wall Street, New York City.

GEORGE R. ROWLAND,
Formerly with the Continental Iron Works.
Draughtsman and Constructing Engineer.
Drawings, Specifications and Estimates furnished for the construction of new works or alteration of old works. Special attention given to Patent Office drawings.
Office, No. 245 Broadway, N. Y. City.

H. C. SLANEY,
Gas Engineer
466 Sixth Street, Brooklyn, N. Y.
Plans, Specifications and Estimates furnished for New Works, Alteration or Extension of Old Plants.

T. G. LANSDEN,
Consulting and Contracting Gas Engineer
Estimates, Plans and Specifications for New Works (Coa or Water Gas), and for Extensions or Alterations.
Room H, 108 N. 4th St., St. Louis, Mo.

WM. HENRY WHITE,

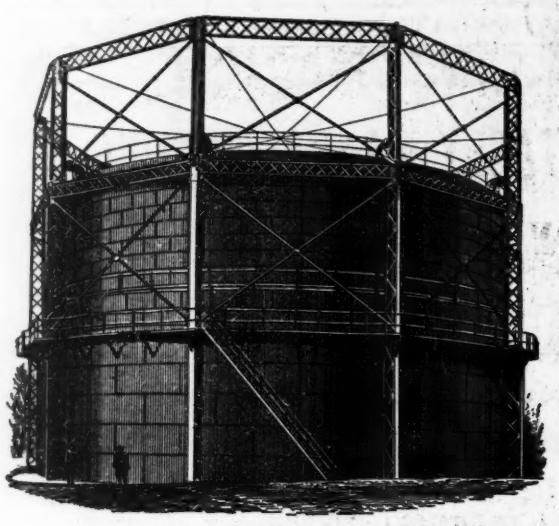
No. 32 Pine Street, - - - New York City.

ENGINEER AND CONTRACTOR FOR THE

ERECTION AND EXTENSION OF

GAS, WATER, AND ELECTRIC LIGHT WORKS.

Correspondence with Gas Companies contemplating extending or improving their Plants respectfully invited
Plans and Estimates Furnished.



1842 * Deily & Fowler, * 1896

LAUREL IRON WORKS.

Office, No. 39 Laurel Street, Philadelphia, Pa.

BUILDERS OF

Gasholders

Single or Telescopic. With or Without Iron or Steel Tanks.

OIL TANKS, WATER TANKS, AND GENERAL WROUGHT IRON WORK.

JAMES R. FLOYD & SONS,

Successors to HERRING & FLOYD,

Oregon Iron Works,

West 20th and 21st Streets, Between 10th & 11th Avenues, New York City.

Engineers and Contractors for the Construction of Gas Works.

MANUFACTURERS OF ALL KINDS OF CASTINGS AND GENERAL IRONWORK FOR GAS APPARATUS.

Bench Castings, Regenerative and Half Regenerative Furnace Castings, Condensers, Tower Scrubbers, Mechanical Scrubbers, Purifiers, Malleable Iron Retort Lids, Self-Sealing Retort Lids, Hydraulic Hoist Purifier Carriage, Crosses, Tees, Bends, Angles, Reducers, S-Bends, Sectional Sleeves, Plugs, Caps, Street Drips, etc., always on hand.

WOOD'S GAS SCRUBBING AND ENRICHING APPARATUS.

In use at Syracuse, Auburn, Watertown, Cortland and Geneva, N.Y.; Elizabeth, N. J.; Boston, Mass.; Jamaica Plain, Mass.; Providence, R. I.; Northern Liberties Gas Co., Phila.

Sole Manufacturers of the OGDEN QUICK-MOVING VALVE.

Premium Awarded, World's Columbian Exposition.

HEARNE CENTER SEAL, Operating One, Two, Three or Four Boxes.

SCIENTIFIC BOOKS.

GAS MANUFACTURE, by William Richards. 4to., with numerous Engravings and Plates, in Cloth binding. $12.

TECHNICAL GAS ANALYSIS. $3.

GAS CONSUMER'S HANDYBOOK, by Wm. Richards, C.E. 20 cents.

PRACTICAL TREATISE ON HEAT AND VENTILATION, with Special Relation to Illuminating, Heating and Cooking by Gas. By E. E. Perkins. $1.25,

CHEMISTRY OF ILLUMINATING GAS. By Norton H. Humphrys. $2.40.

PRACTICAL TREATISE ON HEAT By Thomas Box. 2d edition. $5.

PRACTICAL PHOTOMETRY: A Guide to the Study of the Measurement of Light. By W. J. Dibdin. $3.

CHEMICAL TECHNOLOGY: Vol. I., *Fuel and Its Applications*, $5. Vol. II., *Lighting*, $4.

IRONWORK: Practical Designing of Structural Ironwork. By H. Adams. $3.50.

GAS WORKS: Their Arrangement, Construction, Plant and Machinery. $5.

PRACTICAL HANDBOOK ON GAS ENGINES, by G. Lieckfield. $1.

LIQUID FUEL FOR MECHANICAL AND INDUSTRIAL PURPOSES. By E. A. Brayley Hodgetts. $2.50.

COAL, SPONTANEOUS COMBUSTION OF. By Thomas Rowan, C.E. $2.

COAL: Its History and Use. By Prof. Thorpe. $3.50.

THE GAS WORKS OF LONDON. By Colburn. 60 cents.

HEAT A MODE OF MOTION. By John Tyndall. $2.50.

THE MANAGEMENT OF SMALL GAS WORKS. By C. J. R. Humphreys. $1.

MANUAL FOR GAS ENGINEERING STUDENTS. By D. Lee. 40 cents.

THEORY OF HEAT. By J. Clerk-Maxwell. $1.50.

AMMONIA AND AMMONIUM COMPOUNDS. By Dr. R. Arnold. $2.

DIGEST OF GAS CASES. $5.

DISTILLATION OF COAL TAR AND AMMONIACAL LIQUOR. By Geo. Lunge. New edition. $12.50.

A TREATISE ON THE COMPARATIVE COMMERCIAL VALUES OF GAS COALS AND CANNELS. By D. A. Graham. $3.

A TEXT BOOK OF INORGANIC CHEMISTRY. By Prof. Victor Von Richter. $2.

ILLUMINATING AND HEATING GAS. By W. Burns. $1.50

HANDBOOK FOR MECHANICAL ENGINEERS. By H. Adams. $2.50.

TREATISE ON MASONRY CONSTRUCTION. Baker. $5.

GAS ENGINEER'S LABORATORY HANDBOOK. By Jno. Hornby, F.I.C. $2.50.

GAS LIGHTING AND GAS FITTING. By W. P. Gerhard. 50 cents.

PRACTICAL PLUMBING. By P. J. Davies. $3.

AMERICAN PLUMBING. By Alfred Revill. $2.

CEMENT; A Manual of Lime and Cement, their Treatment and Use in Construction. By A. H. Heath. $2.50.

ELECTRICITY.

INDUSTRIAL PHOTOMETRY, with Special Application to Electric Lighting. By A. Palaz, Sc.D. $4.

ELEMENTS OF ELECTRIC LIGHTING, Including Electric Generation, Measurement, Storage and Distribution. By Philip Atkinson. $1.50.

ELECTRIC TRANSMISSION OF ENERGY. By G. Knapp. $3.

ELECTRICIAN'S POCKETBOOK. By Monroe and Jamieson. $2.50.

MAGNETISM AND ELECTRICITY. By J. Overend. 40 cts.

DYNAMO BUILDING. By F. W. Walker. 50 cents.

DOMESTIC ELECTRICITY FOR AMATEURS. By E. Hospitalier. $2.50.

PRACTICAL MANAGEMENT OF DYNAMOS AND MOTORS. $1.

PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES. $1.

ELECTRIC LIGHT FITTING. $2.

PRACTICAL ELECTRICITY. $2.50.

ELECTRICITY FOR ENGINEERS. $2.50.

ELECTRIICITY, Its Theory, Sources and Applications. By John T. Sprague, M.I.E.E. $6.

The above will be forwarded by express, upon receipt of price. If sent by mail, postage must be added to above prices. We take especial pains in securing and forwarding any other Works that may be desired, upon receipt or order All remittances should be made by check, draft, or post office money order. No books sent C.O.D.

A. M. CALLENDER & CO., 32 Pine Street, New York.

GAS AND WATER PIPES.

THE OHIO PIPE COMPANY,

MANUFACTURERS OF

Cast Iron Gas & Water Pipe,

BRANCH AND SPECIAL CASTINGS.

Gas-House Bench Castings, Hydraulics, Lamp Posts, Flange Pipe and Specials, Architectural Castings, Building Columns, Joists, Cellar Grates, Sash Weights, etc.

GENERAL FOUNDERS AND MACHINISTS

Columbus, Ohio.

Cast Iron Pipe For Natural or Artificial Gas, Flange Pipe, Electric Light Posts.

The Addyston Pipe & Steel Co., Cincinnati, O.

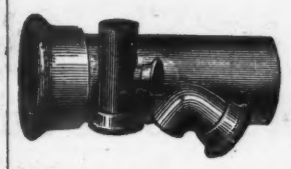
The Chemistry of Illuminating Gas.

By NORTON H. HUMPHRYS. Price, $2.40.

A. M. CALLENDER & CO., 32 PINE ST., N. Y. CITY.

GAS METERS.

WARREN FOUNDRY AND MACHINE CO.,



Established 1856. Works at Phillipsburgh, N. J.

New York Office, 160 Broadway.

CAST IRON WATER AND GAS PIPE,

FROM THREE TO FORTY-EIGHT INCHES DIAMETER. ALSO, ALL SIZES OF

Flange Pipe for Sugar House and Mine Work. Branches, Bends, Retorts, etc., etc

EASTERN OFFICE: NEW YORK, 152 BROADWAY. WESTERN OFFICE CHICAGO, MONADNOCK BLK

M. J. DRUMMOND

MANUFACTURER OF

CAST IRON

FLANGE

GAS AND WATER PIPE

AND GENERAL FOUNDRY WORK

GEORGE ORMROD, Mangr. & Treas., Emaus, Pa.
JOHN DONALDSON, Prest., Betz Bldg., Phila., Pa

EMAUS PIPE FOUNDRY.

DONALDSON IRON COMPANY. EMAUS, PA

MANUFACTURERS OF

CAST IRON PIPE AND SPECIAL CASTINGS

FOR WATER AND GAS.

Also, FLANGE PIPE, LAMP POSTS, Etc.

JOS. R. THOMAS,

No. 32 Pine Street, N.Y. City

CONSULTING AND CONSTRUCTING

Gas Engineer and Contractor

PLANS, SPECIFICATIONS AND ESTIMATES FURNISHED.

Contracts taken for all Appliances required at a Gas Works,

Either for New Works or Extensions to Old Plants

DAVID LEAVITT HOUGH,

26 CORTLANDT ST., N.Y. CITY.

Consulting Engineer

Investigations and Appraisals.
Designs and Estimates.

Contractor.

Machinery and Structures.
Gas and Water Pipe.

Special Agent for Selling & Purchasing

1894 DIRECTORY 1894

OF AMERICAN GAS COMPANIES

Price, - - - - - - - - $5.00.

A. M. CALLENDER & CO., - - No. 32 Pine Street, New York.

PRACTICAL HANDBOOK ON

GAS ENGINES

With Instructions for Care and Working of the Same.

By G. LIECKFELD, C.E.

Translated with Permission of the author by GEO. M. RICHMOND, M.E.

Price, $1.00.

A. M. CALLENDER & CO., 32 Pine Street, New York.

Established 1849. With he best facilities for manufacuring, is enabled to furnish reable work and answer orders promptly.

NATHANIEL TUFTS,

153 Franklin St., Boston, Mass.

C. W. HINMAN, - - Manager.

MANUFACTURER OF

DRY GAS METERS.

Station Meters of any Capacity.

Test and Experimental Meters, Pressure Registers, Pressure Gauges.

METER PROVERS, PHOTOMETERS, STREET LANTERNS, ETC., ETC.

Apparatus for the Chemical Testing of Gas and Gas Liquor.

CHARLES E. DICKEY. JAMES B. SMALLWOOD. CHARLES H. DICKEY.

THE MARYLAND METER AND MANUFACTURING CO.

Established 1866.

BALTIMORE, North & Saratoga Sts. **CHICAGO, 107 West Monroe St.**
NEW YORK, 838 Broadway. **SAN FRANCISCO, 221 Front St.**
BOSTON, 92 Water Street, Rooms 21 and 22.

CONSUMERS' & STATION METERS, PRESSURE GAUGES, Etc., Etc.

"Success" and "Perfect" Gas Stoves.

THE GOODWIN METER COMPANY,

1012-1018 Filbert Street, Philadelphia, Pa.

MANUFACTURERS OF

Consumers' and Station Meters,

Standard Photometrical and Analytical Gas Apparatus

"SUN DIAL" GAS COOKING AND HEATING STOVES.

Particular attention given to Repairing Meters and Scientific Apparatus. . . . .

GEORGE B. EDWARDS, Agent,
113 Chambers Street, N. Y. City.

METRIC METAL COMPANY,

MANUFACTURERS OF

DRY GAS METERS

For all Kinds of Service.

ALSO MAKERS OF THE

MATCHLESS CLASSIC GAS COOK STOVES AND RANGES.

Send for '96 Stove Catalogue. Factory at Erie, Pa.

THE AMERICAN METER CO.

Established 1834. Incorporated 1863.

WET AND DRY GAS METERS. PRESSURE REGISTERS. METER PROVERS.
STATION METERS. PRESSURE & VACUUM REGISTERS. PORTABLE TEST METERS.
EXHAUSTER GOVERNORS. PRESSURE & VACUUM GAUGES. EXPERIMENTAL METERS.
DRY CENTER VALVES. CRESSON GAS REGULATORS. AMMONIA TEST METERS.
GOVERNORS FOR GAS WORKS. MARSLAND WATER METERS. BAR & JET PHOTOMETERS.

Manufactories:
512 West 22d St., N. Y.
Arch & 22d Sts., Phila.

GAS STOVES.
SUGG'S "STANDARD" ARGAND BURNERS,
SUGG'S ILLUMINATING POWER METER,
Wet Meters, with Lizar's "Invariable Measuring" Drum.

Agencies:
125 & 127 S. Clinton Street, Chicago.
810 North Second Street, St. Louis.
222 Sutter Street, San Francisco.

HELME & McILHENNY,

(Established 1848.)

Gas Meter Manufacturers

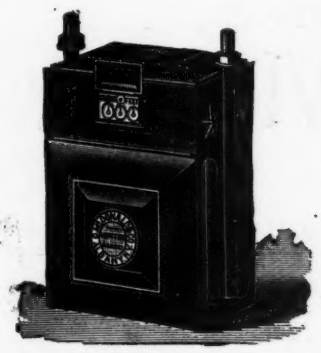
1339 to 1349 Cherry Street, Philadelphia, Pa.

Wet and Dry Gas Meters, Station Meters, Experimental Meters, Meter Provers, Center Seals, Pressure Registers, Governors, Indicators, Photometers

AND ALL OTHER KINDS OF APPARATUS FOR USE IN GAS WORKS.

FOULIS' PATENT STATION AND DISTRICT GOVERNORS.

REPAIRING DEPARTMENT.—We employ a special force of skilled workmen repairing meters of ALL MAKERS.



D. McDONALD & CO.,

Established 1854.

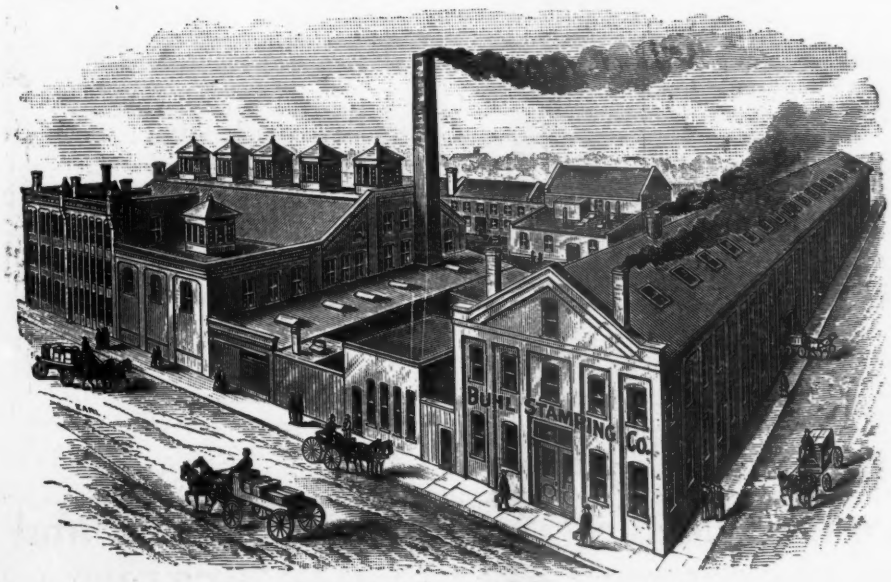
511 West 21st Street, NEW YORK CITY.
51, 53 & 55 Lancaster St., ALBANY, N. Y.
34 & 36 W. Monroe St., CHICAGO, ILL.

MANUFACTURERS OF

Wet and Dry Gas Meters

STATION METERS, EXPERIMENTAL METERS, METER PROVERS, PRESSURE & VACUUM REGISTERS & PRESSURE GAUGES.

Meters of all makers Thoroughly Repaired.



T. D. BUHL, Pres't. CHAS. H. JACOBS, Vice-Pres't & Manager.

BUHL STAMPING CO.

Detroit, Mich.

Makers of Gas Meters.

OUR equipment embraces the Latest and Most Improved Machinery. We make our own Tin Plate. We claim for **"BUHL" METERS, Increased Durability,** with propability of **Fewer and Less Expensive Repairs,** and **More Accurate Adjustment.** Comparisons invited. Meters of other makers promptly repaired. Mail orders solicited.

The Advertisement of the

OTTO GAS ENGINE WORKS,

33d and Walnut Streets, Philadelphia,

New York, 18 Vesey St. Boston, 19 Pearl St., Chicago, 245 Lake St.,

Occupies this space every alternate week.

JOHN J. GRIFFIN & CO.,

1513-1515-1517-1519-1521 Race Street, Philadelphia.

52 Dey Street, New York. WM. S. GRIBBEL, Manager.

75 N. Clinton St., Chicago. FREDERICK WAUGH, Manager.

MANUFACTURERS OF

STATION METERS, CONSUMERS' METERS,

Provers, Registers, Gauges, Experimental Apparatus, Etc.

Prompt Attention Given to All Repairing.

OUR SPECIAL NATURAL GAS METER

Is the Best ever offered. Over 30,000 now in use.

We manufacture in the United States, under the **SAWER & PURVES PATENTS,** the

Positive Prepayment Meter.

. . SIMPLE . .

. DURABLE .

. ACCURATE .

. RELIABLE .

All Parts Interchangeable

This Meter is an unqualified success in Great Britain. Its simplicity of construction, and the positive character of the service performed by it, have given it pre-eminence.

Needs only the care given an ordinary Meter. Saves MONEY, TIME and 'CONSUMERS, 'Dispenses with "DEPOSITS" and increases OUTPUT.